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GASOLINE CATERPILLAR TRACTION ENGINE HAULING ELECTRICAL MACHINERY NEAR THE MOJAVE DESERT.

A GASOLINE CATERPILLAR TRACTION ENGINE.

A GASOLINE CATERPILLAR TRACTION ENGINE

CARRYING WATER ACROSS THE MOJAVE DESERT.

In the construction of an aqueduct and a system of reservoirs for a municipal water supply, the city of Los Angeles has voted bonds to the extent of twenty-three millions of dollars, and has undertaken an engineering feat of considerable magnitude, under the direction of Chief Engineer W. H. Mulholland and Assistant Chief Engineer J. B. Lippincott.

The water is being brought from Owens River, a distance of 230 miles, through 30 miles of concrete-lined tunnels and steel syphons, across the barren waste of the Mojave Desert, by means of a concrete ditch, into the city.

One of the peculiar problems which had to be solved was that of transportation of material and supplies to the line of the aqueduct. A railroad was built as near as possible to the aqueduct, but materials have to be hauled across the desert, up into the mountains, and over grades varying from 10 to 30 per cent.

The engineers in charge found that the most practical solution of the transportation problem was the use of a new type of traction engine, which has been popularly called the "caterpillar," and which has been described in these columns. The essential difference between these traction engines and those of the ordinary type lies in the fact that the large drivers of the regular wheel traction engine have been replaced by an endless platform belt. This engine, when traveling over the ground, in reality lays its own track, over which it travels.

The first American engine of this type was built in 1903, and is the product of the mind of Mr. Benjamin Holt, president of the Holt Manufacturing Company of Stockton, Cal. After three years of experimental work, a steam caterpillar traction engine was sent to the State of Louisiana, to plow in the soft, boggy rice lands of that State. Since developing the steam caterpillar traction engine, the design and construction of a gasoline caterpillar traction engine has been completed.

The weight of the gasoline caterpillar traction engine is 7½ tons, and is carried by five truck wheels 10 inches diameter, which are constructed similar to those used on railroad cars. The truck wheels are supported on short steel axles, fastened in an auxiliary frame and securely fixed to the main frame of the engine. The truck wheels run on the inner surface of the endless chain, the overlapping links of which form a double steel track.

To each link of this track is fastened a pressed-steel shoe and plate. These shoes and plates come in contact with the ground, and correspond to ties of a railroad track. The main advantage of this construction is in the large tractive surface it affords, each platform wheel having the equivalent tractive surface of a round wheel 54 feet in diameter. The endless chain belt is carried by two sprockets, the rear one of which is a driver, the front one acting merely as an idler or tightener. The rear sprocket of the freighting engine has cast with it a band, on which is operated a brake, a necessary precaution in operating on steep grades.

The power plant consists of a 40-horse-power vertical, 4-cylinder marine type motor, having four separate 6-inch by 8-inch cylinders. The engine is water-cooled by means of a closed type of radiator built of copper spiral tubing. To the crankshaft of the gasoline engine is coupled a double universal joint, and through this extension, by means of a multiple-disk friction, steel bevel pinions and gears and intermediate gears, the driving power is transmitted to the platform wheels or endless belt.

The normal speed is two miles an hour; but by means of four cast-steel gears and an auxiliary countershaft, a higher speed of approximately four miles per hour may be accomplished.

The crankshaft extension carries two bevel pinions, which drive two bevel gears, the power being transmitted to the bevel gears and their respective shafts by means of frictions of the male and female type. By the use of these frictions, each platform wheel may be driven separately or both may be driven together.

The following are the outside dimensions of the traction engine: Height, 10 feet 3 inches; width, 7 feet 8 inches; length, 17 feet 8 inches.

The fuel consumption of these engines under load averages two gallons of distillate per ton mile.

The original idea the manufacturers had in view was to build an engine which could be used for plowing on soft peat lands. On this kind of soil this engine has plowed, seeded, and harrowed a strip 144 inches wide; in adobe soil it has hauled 100 inches of plows; while in sandy loam it has taken care of 180 inches of heavy traction-engine plows. These engines are also used in the harvest fields of the West for hauling combined harvesters, which cut, thresh, clean, reclean, and sack the grain, harvesting in one operation a strip 16 feet wide.

The caterpillar engine is most efficient when operating over sandy roads and steep grades. Freighting engines of this type are being used summer and winter over the muddiest kind of roads, for the transportation of supplies and material. The freighting engines are hauling loads of 7½ tons to 10 tons up 18 and 20 per cent grades, and loads of 33 tons on good hard roads. The "caterpillar" has climbed a 62½ per cent grade when not loaded, and stopped and started on the grade without any apparent effort.

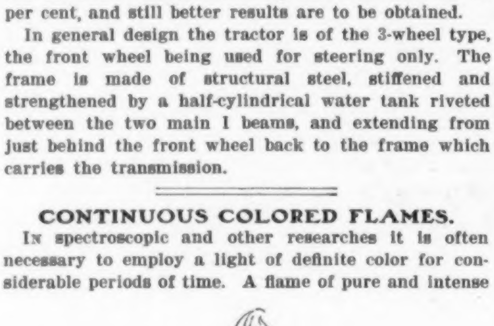
There are a number of these engines operating on the Mojave Desert, where they have taken the place of teams. These engines seem to be capable of going almost to any place, whether there is a road or not.

In the construction of the Los Angeles aqueduct, the cost of transportation by these engines over the old method of animal hauling has been reduced 25 per cent, and still better results are to be obtained.

In general design the tractor is of the 3-wheel type, the front wheel being used for steering only. The frame is made of structural steel, stiffened and strengthened by a half-cylindrical water tank riveted between the two main I beams, and extending from just behind the front wheel back to the frame which carries the transmission.

CONTINUOUS COLORED FLAMES.

In spectroscopic and other researches it is often necessary to employ a light of definite color for considerable periods of time. A flame of pure and intense



APPARATUS FOR THE PRODUCTION OF COLORED FLAMES.

color can be maintained for hours by means of the simple apparatus here described and illustrated, which can be made of materials to be found in every laboratory.

To the gas pipe is connected a bent glass tube (*B*) which passes over the rim of a beaker of Bohemian glass, follows the inner surface of the beaker to the center of the bottom, and thence rises vertically, nearly to the top of the vessel. The end of this tube is surrounded by a larger glass tube, the upper end of which is tapered and enters, above the rim of the beaker, the bottom of a wide porcelain tube, which serves as a Bunsen burner. A wire, wound in a helix around the small glass tube, and then around the larger tube which surrounds it, forms the cathode of a galvanic battery, of which a rod of carbon (*F*) forms the anode. The beaker is filled very nearly to the top of the small glass tube, with a solution of the salt from which the coloration of the flame is to be obtained. The gas is then turned on and the mixture of gas and air is ignited at the top of the porcelain burner. The hydrogen disengaged at the cathode rises into the burner, carrying with it minute drops of the solution which give the colorless Bunsen flame an intense and uniform color.

WHAT A SKYSCRAPER CONTAINS.

If one of New York's modern skyscrapers, such as the Metropolitan Life or the Singer Building, with its cloud-piercing tower, could be picked up bodily and dropped on some prairie, there would be practically everything needed to start a little city, including the population.

Take the Singer Building for instance. It contains 136 miles of various kinds of metal piping. The telephones, elevators, electric lights, fans, and clocks require 3,425 miles of wire, which, if stretched out, would extend from the top of the Singer Building to the top of the Eiffel Tower in Paris, with 300 miles left over. The steel used in the construction of the Singer Building, if made into ¾-inch wire cable, would reach from New York to Buenos Ayres, a distance of 7,100 miles.

The terra-cotta floor blocks in the building, if spread out on a plane, would cover 8.36 acres. Placed end to end, they would extend 97 miles, or from New York to Philadelphia. It contains 5,033,800 bricks, and these, laid end to end, would reach 635 miles, from New York to Detroit. They would pave a footpath 12 inches wide from New York to Boston.

This modern skyscraper contains 101 tons of sheet copper, enough to cover 4.64 acres. The copper, combined with the statuary bronze in the building, would yield 46,208,000 cents, or $462,080.

If the concrete in the foundation of the building were all loaded on two-horse trucks, it would make a continuous line of 10,180 trucks, 38 miles long, or twice the distance from the Singer Building to Yonkers.

The steel in the building would make 125 large type mogul locomotives; that is, a continuous line of engines for a mile and a half. It would make a 74-mile stretch of heavy modern track, rails, spikes, and tie-pieces. Made into elevator cables, it would extend 7,100 miles, and if the total lengths of all the strands of wire in the cables were put together, they would cover an area of 50 acres.

There are 13.3 miles of picture molding in the building. If all the moldings for the doors, pictures, and windows were put in a straight line they would reach 60 miles.

More than 5,541 tons of mortar were used in the masonry. This would make a path 14 inches wide and 1 inch thick from New York to Washington, a distance of 240 miles. About 197 tons of paint were used on the various surfaces. This would cover a board fence 6 feet high from New York to Springfield, 128 miles, with one coat.

There are 25.4 acres of wall area in the new skyscraper. It would make a line of plaster 12 inches wide from New York to Boston.

The glass in the building, 85,203 square feet, would make a continuous show window 6 feet high on one side of Broadway from Liberty to Thirty-fourth Street. There are 256,000 square feet of metal lath, or 53 acres. To support these laths 49.1 miles of structural angle irons were required, together with 130 miles of tying wire and 110,000 bolts.

There are 8.85 miles of elevator cables in the building, and 9 fans capable of blowing 6,820,000 cubic feet of air an hour, which would make it possible for an ordinary-sized town almost to generate its own tornado.

The lighting system of the Singer Building represents a capacity of 278,800 candle-power. The boilers of the building, to generate light, heat, power, etc., must yearly generate 150,000,000 pounds of steam. This will take 18,000,000 gallons of water and 8,000 tons of coal.

The tower elevator cars travel about 600 feet a minute. With the building fairly well filled the cars will travel 310 miles daily and make a yearly total of 98,270 miles, or about four times the distance around the earth. The length of the highest elevator shaft is 546 feet 9 inches, the tower from curb to roof being 612 feet.

There have been expended in the construction of the Singer Building about 860,000 days' labor.

The Metropolitan Life Building affords much larger figures than these, as the tower is not only 83 feet higher than the Singer structure, but is of larger proportions throughout.—Industrial World.

A terrible accident occurred at Cologne recently, when the central span of the new bridge which is to connect the freight station with the Deutz side of the stream, without the slightest warning collapsed and fell into the Rhine, carrying with it fifty workmen, sixteen of whom were drowned and a large number injured. The bridge was not completed and the central span was supported by scaffolding, which it is supposed was not sufficiently strong. As in the case of the Quebec bridge, disquieting signs had been noticed by the engineers some days before the accident occurred, and a special scaffolding was erected to strengthen the final sections. When the accident occurred a group of workmen were in the middle of the bridge placing a crosspiece in position. This gave way, and the men were suddenly thrown into the river. Help was soon forthcoming from the many boats in the vicinity and the majority of the men were picked up. When the roll was called over a little later sixteen were found to be missing and it is feared were drowned. Some of the men who were rescued sustained injuries and had to be taken to the hospital at Cologne.

DROPPING PROJECTILES FROM BALLOONS.

THE MILITARY POSSIBILITIES OF THE DIRIGIBLE AIRSHIP.

BY CAPT. HILDEBRANDT.

At the first peace conference at the Hague it was decided to prohibit the throwing of explosive projectiles from balloons. This was a very singular decision, for it was not accompanied by its logical corollary, the prohibition of shooting at balloons. It was absurd to demand that aeronauts should allow themselves to be attacked, but should not be permitted to defend themselves. The realization of this absurdity caused the prohibition to be repealed by the last Hague conference, so that aeronauts are now permitted to defend themselves and attack the enemy by any means recognized in civilized warfare.

The idea of employing balloons for attack as well as for scouting is by no means new. The Austrian besiegers of Venice in 1849 used free, unmanned balloons to drop bombs among the enemy's ranks, but the practice was soon discontinued because unsuspected contrary currents in the upper strata of the atmosphere caused some of the missiles to fall within the Austrian lines.

The French experimented with the discharge of projectiles from dirigible balloons in 1905, soon after the first successful flights of the Lebaudy airship. Bags of sand, equal in weight to hand grenades, were thrown at previously designated parts of the fortress of Toul. According to report, satisfactory results were obtained.

The principal difficulty is due to the sudden ascent of the balloon when its weight is diminished by the dropping of the projectile. This ascent involves great waste of gas. To prevent or moderate it, the French place inside the gas bag a "ballonet" filled with air and connected with a quick-acting air pump, with which 35 cubic feet of air can be forced into the ballonet in one second. In this way the dropping of a projectile weighing 40 pounds can be compensated, by forcing in an equal weight of air, in about 16 seconds, during which time the balloon cannot rise very far, especially as the pump may be started before the projectile is dropped.

The balloon corps of the German army has made some experiments in throwing projectiles from captive balloons, and purposes continuing the experiments with dirigibles.

The French have proved that the sudden ascent and resultant loss of gas can be obviated by pumping in air. Another objection often made is that only a few projectiles can be carried in a balloon, but there is no necessity of employing projectiles as heavy as those which are fired from guns and which are covered with heavy steel armor, not so much in order to increase their destructive effect as for the purpose of resisting the enormous pressure generated in the gun at the instant of discharge. Very thin-walled shells of moderate weight, though containing large charges of explosives, would be suitable for dropping from balloons. The possibility of carrying a large number of very light explosive projectiles has recently been afforded by Gehre's discovery of an exceedingly light and very powerful explosive. Balloons no larger than Parseval's rapid and easily dirigible airship could carry a sufficient quantity of ammunition of this sort. Another objection made to the employment of balloons for offensive operations is based on the alleged difficulty of hitting small objects from a balloon, which must float at an elevation of at least 5,000 feet, in order to avoid destruction by artillery and infantry fire. But it is not clearly evident why it should be more difficult to hit the mark from this elevation than from the far greater horizontal distances which are usual in artillery fire. Armored batteries, small in area and quite invisible, have been destroyed by unmounted artillery at distances of from 20,000 to 30,000 feet. Even in firing on land it is necessary to make allowance for winds, and although air currents would affect shells dropped from balloons more seriously than projectiles discharged with great velocities, it still ought to be possible to make a fair proportion of hits from a balloon.

The aeronaut has the great advantage of being able to observe accurately the result of his fire. The observation of the shots is one of the most difficult tasks of the artillerist, and one of the most important, as ultimate success depends on knowing whether tentative shots have struck within, at, or beyond the goal. But from a height of 5,000 feet the point of striking can be seen very clearly with the naked eye, and the enemy, furthermore, gains no security by masking his batteries, for the surrounding country can be surveyed very accurately from a balloon overhead.

It may be objected that a balloon would inevitably be shot down before it had penetrated far within the enemy's lines. But the flight could be made in safety at night when, even in bright moonlight, an airship at a little distance is absolutely indistinguishable from the sky. The sound of the propellers is audible to a considerable distance, but it would be impossible to aim accurately by sound alone. When the airship has taken its position directly over the enemy's center it is practically invulnerable even in broad daylight, because shots fired at it would almost inevitably fall upon some of the enemy's works or troops. From this position it would be difficult to send dispatches. At present these can be forwarded only by pigeons, but it is probable that some practical method of sending messages from balloons by wireless telegraphy will soon be devised.

These considerations make evident the importance of experiments in dropping projectiles from balloons. This method of attack will certainly play a great part in future wars. In France, it is reported, rules governing this new method of warfare have already been laid down.

Exposives are not the only substances that can be used in this way. There are, for example, compounds of phosphorus which ignite on contact with air. Such compounds, inclosed in shells of fragile material and dropped from balloons, might prove very effective in destroying the enemy's fortifications and magazines.—Translated from Umschau.

PRESENT AND PROPOSED METHODS OF MEASURING THE EFFICIENCY OF AEROPLANE PROPELLERS.

The method commonly employed in measuring the efficiency of aerial propellers is wrong in principle and gives erroneous and misleading results. Hence we see constructors promising, in good faith, efficiencies of 90 and 97 per cent, and writers of eminence asserting that the efficiency almost always exceeds 70 per cent.

The efficiency is measured "at a fixed point" by causing the propeller to revolve, without advancing or receding, and measuring the thrust produced, in the direction of the axis, by a given horse-power.

The conditions of the experiment are very different from those of rapid flight through the air, in which the friction between the air and the propeller is enormously increased, and no account is taken of the resistance opposed by the air to the forward movement of the aeroplane. In fact, no work of propulsion is performed, or even imitated, the sole result being a thrust which may be employed for propulsion. In these conditions, the propeller is comparable to a lever which supports a motionless weight, and thus exerts a stress but performs no work.

The true efficiency of a propeller driving an aeroplane is the ratio between the work of propulsion and the energy consumed, the work of propulsion being the product of the travel of the aeroplane multiplied by the resistance opposed to its forward movement. I am confident that this efficiency is much less than 50 per cent, and that the axial thrust of 20 or 25 pounds per horse-power deduced from experiments conducted by the method described above is not maintained in actual flight.

A fair imitation of the conditions of flight as they directly affect the propeller itself can be obtained by placing the propeller in a tube in which an air current of any desired velocity is produced by blowers. A still better plan would be to employ a tube large enough to admit the entire aeroplane, with transverse partitions which would confine the current to the cross section of the latter. The aeroplane would be held in place by six cables stretched in the median fore and after vertical plane. Two of these cables, supporting the weight of the machine, would extend vertically upward from the bow and stern, pass around the pulleys and terminate in dynamometers. Two other cables would run downward from points directly under the points of attachment of the supporting cables. The fifth cable would extend forward horizontally from the bow, the sixth would extend backward from the stern, and each of the cables would be attached to a separate dynamometer.

This arrangement would keep the machine absolutely stationary and yet would indicate separately the various stresses to which it would be subjected in flight. The tension of the bow cable would give the tractive effort required to propel the vehicle in still air with a speed equal to the measured velocity of the air current to which it is subjected in the experiment. Then, the propeller having been started, the indications of the dynamometers of the bow and stern cables, combined with the measurement of the power employed, and the velocity of the air current, would give information of practical value relative to the power required to maintain various speeds. The dynamometers of the vertical cables would give similar information regarding the weight and the lifting power at various speeds. There would be no difficulty in maintaining a steady air current of any desired velocity, up to 30 meters per second or more than a mile a minute. Every element of the experiment could be varied at will and the elements of construction—position, form and area of aeroplanes and propeller blades, etc.—could be modified according to the results obtained.

The inclined tracks, revolving arms, and other devices employed in testing aeroplanes give unreliable indications, as they fail utterly to represent the conditions of actual flight. It is far simpler and better to keep the machine stationary and set the air in motion. The plan suggested would give an ideal method of experimentation, safe, convenient, and easy in operation and accurate in result.

A testing establishment of this sort could be constructed for less than $20,000. This would be a small sum for the generous patrons who have done so much to encourage aviation, and its contribution by private persons would enable aviators to dispense with the slow and usually barren aid of governments. The large sums that are expended for prizes promote the vogue of aviation but do little to advance the art. A small part of this money might well be spent to favor scientific experiment and construction.

An establishment of this kind might, perhaps, be made self-sustaining and even profitable, if it were conducted by men of unquestioned authority and moderate fees charged for certificates of efficiency, lifting power and other details of aeroplanes submitted to it for examination.

It should be added that Renard has used tubes or tunnels in studying the resistance and stability of airships, and that they are used for similar purposes by the Italian army engineers and by Riaboutchinsky, in his laboratory at Koutchniv. Only small tubes, however, have been used. Drzewiecki is said to be constructing a testing plant of larger dimensions, similar to the one suggested in this article.—Eugene Bolle in Le Génie Civil.

REVISING THE RUSSIAN CALENDAR.

Russia still reckons time by the Julian calendar, which is thirteen days behind the new or Gregorian style. This difference is found an increasing source of trouble in international intercourse, and as long as nine years ago the Russian Public Education Department appointed a commission to study the question of calendar reform. The members are divided into three hostile camps, one rejecting any idea of alteration, one in favor of the Gregorian calendar, and the third advocating the introduction of an entirely new system. Prof. Solodiloff, the prime mover in favor of radical reform, has explained the proposals of his friends to the Academy of Science at St. Petersburg.

The year, he says, should begin at the spring equinox, and the quarters should be reckoned from the equinoxes and the solstices. The first two months of every quarter should have thirty days and the third thirty-one days. Thus each quarter would have ninety-one days, making 364 days for the year. As the solar year has 365 days, 5 hours, 48 minutes, and 49.7 seconds, one day in the year should be simply called New Year's Day, without a week day name.

This disposes of the extra day, leaving the difference at five hours and the minutes and seconds. These in four years' time would but for forty-five minutes make an extra day, which Prof. Solodiloff proposes to call the "Day After New Year." The forty-five minutes would mount up to a day in 128 years, and so the "Day After New Year" should fall out once in 128 years.

There is still a difference of a few seconds, but as this does not amount to a day once in 5,000 or 6,000 years, it may well be disregarded. Under this system, the professor explains, every first day of a quarter would be a Monday, the first day of the second month always a Wednesday, and the first day of the third month always a Friday. It is also proposed to make Easter, from which all church festivals are reckoned, occur at a fixed date, which the ecclesiastical authorities are invited to name.—New York Sun.

THE ROTAPLANE.

AN INGENIOUS ASTRONOMICAL DEMONSTRATION APPARATUS.

BY THE ENGLISH CORRESPONDENT OF THE SCIENTIFIC AMERICAN.

A SIMPLE and ingenious apparatus which is designed to demonstrate certain phases of astronomical phenomena has recently been invented by the Rev. Cecil Thomas, of London, and developed and worked out by Mr. James W. Vickers, A.M.I.C.E., of the same city. As its name implies, it constitutes a plane which rotates, and its object is the demonstration to the observer of the apparent movements of the sun and moon if he were standing at the center of the plane which represents the landscape or seascape as the case may be. It shows graphically the rising and setting of the sun and moon, and their paths through the heavens in every part of the globe.

The general design of the instrument can be gathered from the accompanying illustrations. It is supplementary to the ordinary terrestrial globe, which represents the earth in its true form, that of a sphere, with the conception of the sun at an enormous distance. It is thus possible to follow how the sun traverses a country, continent, or ocean. On the other hand, the rotaplane represents the earth to the observer as it appears—a circular plane or flat disk, the periphery of which forms the horizon, consequently he considers the sun as touching the horizons as indeed it appears to do. He sees how his own landscape with the familiar objects on his horizon passes through the sunlight and can follow its annual progress relative to those landmarks by a simple reference to the points of the compass on the plane.

At the base is a horizontal circular dial similar to that of a clock inscribed with the hours, above which revolves a pointer. Above this is fixed an inclined plane pierced with a circular opening, around the edge of which are inscribed the months of the year, divided into weeks and days, together with the zodiacal signs. This plane represents the ecliptic or sun's path in the heavens. Within its circular opening is carried a circular rotating plane of the same dimensions, capable of revolution within the opening of the zodiacal inclined plane, being actuated by the lower clock dial pointer. The edge or circumference of this plane represents the horizon of the observer if he were standing in the center thereof. Its periphery is boxed like the mariner's compass, and spanning it at right angles is a semicircle representing the meridian with 90 deg. as the observer's zenith, that is vertically above the axis of the rotating plane. This semicircle is continued on the underneath side of the plane to that on which the meridian is shown, and serves the triple purpose of carrying the plane, indicating its inclination, and representing the lower meridian respectively. It moves in a circular groove and is held in position by a set screw. The degrees of latitude are indicated by a pointer. The zodiacal plane is further provided with a small electric lamp representing the sun, which is placed on the point corresponding to any day of the year to be studied, while another lamp is used for the study of the moon. The rotating plane is moved by the pointer indicating the time on the base clock dial.

The position of the sun at any point of the earth can be readily determined by tilting the plane to the latitude required, as indicated by the semicircular plane spanning the under portion of the rotating plane, elevating the north point and so adjusting the dial that when the meridian is directed toward the sun lamp, 12 P. M. on the lower clock face is beneath the hour hand. For precise determinations the clock dial should be more minutely adjusted according to the difference between sun and clock time, at that particular date of the year, but this can be easily found in an almanac. The difference between sun and clock time is principally attributable to the obliquity of the ecliptic to the equator. If the two were in the same plane the meridian would pass equal portions of the ecliptic in equal times. But owing to the angle which the ecliptic makes with the equator equal portions are not traversed by the meridian in equal times. The mean distance per hour is equivalent to that apparently traveled by the sun in approximately fifteen days. When the distance exceeds this the sun is before the clock, when in that particular part of the ecliptic, and *vice versa*. Moreover the inequality of the sun's motion in its orbit also contributes to the difference between sun and clock time, sometimes increasing or decreasing the effect due to obliquity.

With this instrument it is possible to follow the gradual lengthening of the twilight as the polar latitudes are approached until the Arctic and Antarctic circles are reached, where the sun does not set in the northern or southern summer, together with the phenomenon described as the harvest moon; and the possibility of demonstrating that at the equinoxes day and night are equal all over the world and that the sun rises and sets due east and due west respectively in every part of the globe except at the poles, where it neither rises nor sets but continues on the horizon one half above and the other below for the whole twenty-four hours.

The moon travels in an orbit nearly coincident with

THE ROTAPLANE. SIDE VIEW.

the ecliptic, and describes about 13 degrees in 24 hours, which is approximate to the distance traveled by the sun in thirteen days. For the purposes of demonstration the moon can be represented on the zodiacal plane by a small ball placed in the same manner as the electric light. When full the moon is directly opposite the sun, and the ball is therefore placed opposite the lamp or electric light representing the sun. To secure the first quarter the ball is placed one-quarter of the circle from this light, and for the third quarter three-quarters of the circle starting from the light and moving in the direction of the months, while for the new moon the ball is placed with the electric lamp.

Although the moon rises on the average 51 minutes later every day owing to its orbit being inclined to the equator, the variation in the times of rising and setting is considerable in the latitude of Greenwich, and greater still in the higher latitudes, while on the other hand near the equator the variation is but slight. In the Greenwich latitude the times of the moon's rising approximate within half an hour when the moon is in that part of its orbit which is marked

THE ROTAPLANE. FRONT VIEW, SHOWING PARTS, HORIZON PLANE, AND LIGHTS REPRESENTING SUN AND MOON.

March or Aries. This occurs every month, but it is conspicuous only once a year because the moon is full when in Aries only once a year, that is when the sun is in Libra, i.e., September, hence the harvest moon with its fullness, intensity, and clearness. The rotaplane shows readily that that part of the ecliptic in which Aries is situate is less inclined to the eastern horizon than any other part, and more inclined to the western than any other part. The converse is true of the opposite part of the ecliptic, that is the section marked by September or Libra.

With this instrument it is very interesting to follow what takes place in the Arctic circle or latitude 66½ deg. When the moon is traveling from Cancer to Capricorn it rises only 4 minutes later every day and sets about two hours later. The converse obtains when the moon is proceeding from Capricorn to Cancer. The reason is that the whole of the ecliptic is in the horizon at the same time once every day and very much inclined to it twelve hours later. For instance, in latitude 52 deg. on September 21st the moon is full. When the meridian crosses the sun's position on this date the clock hand should point to 12 P. M. on the dial. The moon being full it will be directly opposite to the sun at the point marked March 21st. By turning the clock hand it will be found that the moon rises above the eastern horizon at 6 o'clock. The next evening the moon will have advanced to the point marked April 3rd and will rise about twenty minutes later.

In the foregoing examples the difference in clock and sun time has been ignored for the purposes of simple calculation, but if this difference is adjusted the results will be practically precise. Similarly the northern latitude is used. To ascertain results for southern latitudes it is only necessary to depress instead of elevating the north point, and to read east for west and west for east, together with June for December, July for January, and so on.

The instrument is small and compact, the smallest size measuring about 14 inches cube. The larger machine, measuring about 26 inches cube over all, has the plane modeled with hills, trees, and other formations, as well as cloud arrangements over the sun, in order to show the effects of after-glows. If desired separate path moons can be used to show nodes and to enable eclipses of the sun to be demonstrated and worked out. The rotaplane has aroused considerable interest in English scientific and educational circles since it offers an easy and simple method of demonstrating solar and lunar phenomena and will moreover indicate the most probable causes of the peculiar lights that are observable during the summer nights in various latitudes.

AN ARCHÆOLOGICAL FRAUD.

A SOMEWHAT curious case of falsifying of antiquities was brought to light as a result of a recent lawsuit in Paris. The son of a prominent Egyptologist, M. Urbain Bourriant, offered to M. Guimet, the director of the museum which bears his name, a large block of hard Nubian stone cut in the form of a large scarab with folded wings. On the back of the scarab there was an inscription cut in hieroglyphics. The piece was represented as coming from the excavations made by the archæologist at Bubastis. The inscription mentioned the reception by the king of Nechao, son of Psammetichas, who reigned about 600 B. C., of an explorer sent to the African coasts. The king ordered a book to be made about the expedition, and this was supposed to be the same as the famous periple of Hanno mentioned by Herodotus. M. Guimet accordingly purchased the object for $700. A second scarab was offered by the archæologist's family to M. Capart, curator of Egyptian antiquities of the Belgian museum, and its inscription was the continuation of the former. M. Guimet was prevailed upon to cede his specimen so that both could be kept together in Belgium, the archæologist's family receiving $2,000 for the whole. Because doubts were felt about the authenticity of the specimens, it was decided to submit them to a committee of Egyptologists which was then being held at Berlin. The committee declared the objects to be counterfeit and of recent date. A lawsuit resulting from the decision brought out the truth about the matter. The pieces had been made by the son of the deceased archæologist, who was himself engaged in the archæological career. A sculptor who had furnished them upon his order testified to having made the pieces, but without supposing that they were to be passed off as ancient. The inscription was put on afterward by the young Egyptologist.

For rendering wooden casks impermeable to liquids L. Heim first impregnates the casks with a solution of a suitable colloid, such as glue or gelatine, to which chromates have been added. This is effected by forcing the solution into the pores of the wood from the inside of the cask, under pressure, and subsequently admitting steam. The inside of the cask may then be subjected to the action of light by introducing an electric lamp. A final treatment with a reducing agent (sulphur dioxide) may also be given, in order to remove any excess of bichromates.

RECENT DEVELOPMENTS IN GALVANIZING.

"SHERARDIZING," THE DRY GALVANIZING PROCESS OF COWPER-COLES.

AN interesting plant for the commercial exploitation of the dry galvanizing process or "sherardizing," as it is generally called, has been laid down near London. This process was discovered by Mr. Sherard Cowper-Coles in the course of a series of experiments in the annealing of cast iron. The salient feature of this process is the fact that a metallic coating of zinc can be applied to metal objects by heating them to a temperature below the melting point of zinc and immersing them in zinc dust. The latter is a by-product obtained from the distilling of zinc from the ore. The powder is in a very fine state of division, the particles of zinc covered with a film of oxide having been computed to be between 1/40,000 and 1/50,000 of an inch in diameter. If desired, the zinc dust can be made from scrap zinc by means of a special process which the inventor has evolved.

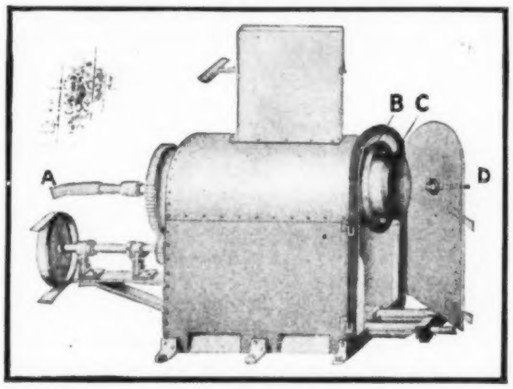
Articles to be galvanized are first treated in the usual manner, but this preliminary cleansing does not need to be so perfectly carried out as in the processes generally in vogue, as the grease instead of retarding galvanizing rather improves the results effected. The objects are then placed in a closed iron vessel which is filled with the zinc dust and can either be rotated or kept stationary. The contents of the drum are raised to a temperature of 500 or 600 deg. F. for a period ranging from thirty minutes to several hours, according to the nature and section of the iron to be galvanized. After the drum is withdrawn from the heating oven or furnace it is left to cool and then opened and the objects removed. They are then found to be coated with a fine homogeneous covering of zinc, the thickness varying according to the length of the period of immersion and the temperature used, but it will be observed that the degree of heating employed is approximately 200 deg. below the melting point of zinc. The process is advantageous from the commercial point of view since it is very economical, because the amount of zinc consumed is less than is requisite in the hot and electro-galvanizing methods, while, moreover, as all the zinc is consumed, there are no skimmings or dross formed as in the hot process.

The zinc dust employed must not be confused with zinc oxide, but is the ordinary commercial zinc dust which can readily and cheaply be procured. Its specific gravity is 6.896 and when tightly packed a cubic foot weighs 200 pounds. In this process temperature and time are the two factors which regulate the thickness of the non-corrosive coating. The receptacle in which the dust is placed and heated should preferably be airtight and the air exhausted so as not to allow the formation of too much oxide. If this is not practicable then it is found advisable to add about 3 per cent by bulk of carbon in a very fine state of division. If the percentage of oxide is allowed to increase beyond certain limits it is found that the resultant deposit lacks its characteristic bright silvery luster. The fact that grease rather assists the process than otherwise is of great advantage, since it enables nuts, bolts, screws, and so forth as produced by the machines to be placed direct in the galvanizing drum without any preliminary preparation or cleaning whatever.

The sherardizing plant which has been erected near London consists of four furnaces capable of taking cylindrical drums measuring 6 feet in length by 2 feet in diameter, with a cubical capacity of two tons of material at one charge, the weight of the iron capable of being dry galvanized per charge varying according to the tightness with which the objects can be packed. The furnaces are heated by Dowson producer gas, which is led by iron pipes to the back of the furnace through brick channels into which air is drawn, the mixture being burnt through cast-iron burners.

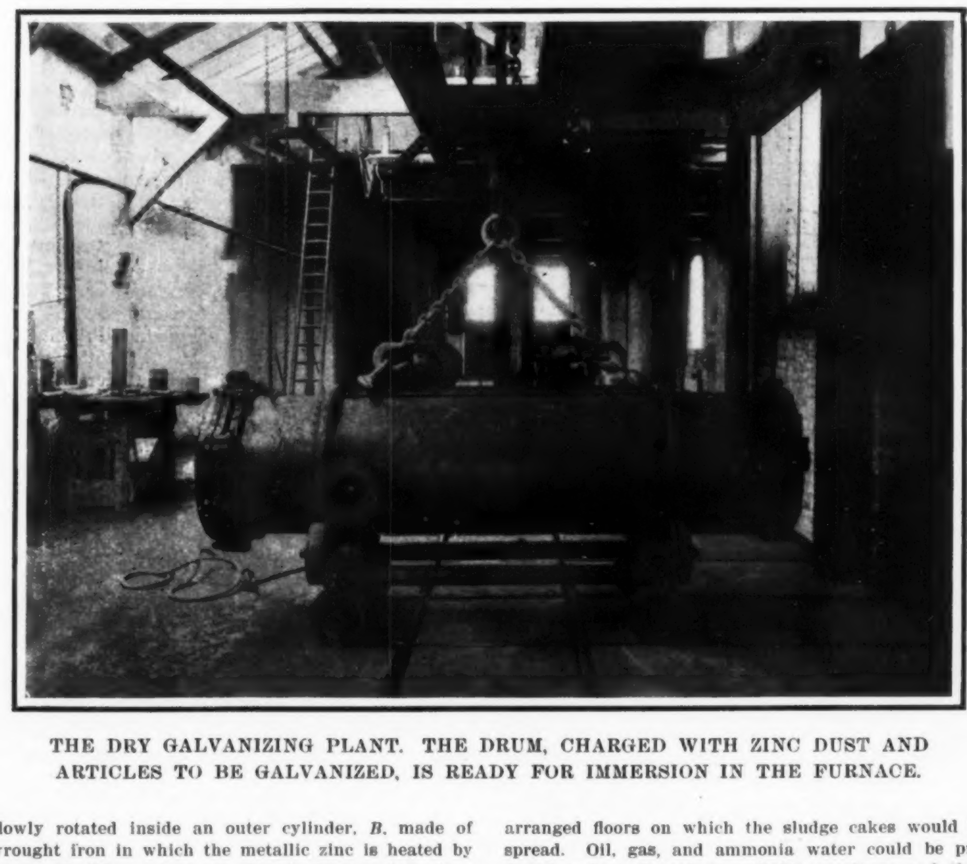
The zinc dust should be dry when placed in the drum, otherwise it will give off hydrogen. The charging of the drum is effected by running the truck on which the drum is placed on a table. One end is then lowered by means of gearing so as to tilt the other end, into which the zinc dust is charged from an upper floor through a canvas chute. The truck is then run along rails until it arrives in front of the furnace. Here it is lifted on to a furnace truck to effect a saving in the first cost of the plant and to save waste of heat. When inside, the door is lowered and the furnace heated up to the required temperature. When the drum has been in the furnace a sufficient time to give the desired result the door is raised and the drum and carriage withdrawn, the drum lifted on to another carriage and run out into an open yard where it is allowed to cool down to a temperature low enough to admit of easy handling.

In practice, iron and steel galvanized by the sherardizing process are found to withstand the ordinary corrosive agents to which galvanized iron is exposed to a remarkable degree. Even after the apparent removal of all the zinc by filing or abrasion the iron is still non-corrosive. This valuable property is doubtless due to the protective action of the zinc-iron alloy formed on the boundary line between the iron and zinc. As sherardizing is carried out at a very much lower temperature than hot galvanizing the temper of steel wire is not reduced as it is in the latter process. A series of tests were made with a number of steel and iron bolts galvanized at varying temperatures and they were found to be equal in tensile strength to bolts which had not be sherardized.



SMALL PLANT FOR GALVANIZING BY THE COWPER-COLES VAPOR PROCESS.

Recently the inventor has devised another process to which the title "cowperizing" has been applied. This is a vapor-galvanizing system and is distinctive from all other processes for the simple fact that the articles coated with zinc are not brought into contact with molten zinc or any of its compounds, but are placed in a separate chamber and submitted to contact with zinc vapor which is circulated through the chamber. A convenient type of this apparatus is shown in the accompanying illustration. There is an inner drum, *C*, made of wire netting or gauze in which the articles to be treated are placed. This cage is slowly rotated inside an outer cylinder, *B*, made of wrought iron in which the metallic zinc is heated by means of either gas or an electric furnace to a temperature sufficiently high to bring about the volatilization of the zinc. Hydrogen gas is then forced through the apparatus through the tube *A* and a pilot light of hydrogen is kept burning through a small hole in the door marked *D*, which forms a gas-tight joint when closed. This process has been highly successful in its application to the decoration of porcelain and metallic surfaces with a brilliant coating of metallic zinc.



THE DRY GALVANIZING PLANT. THE DRUM, CHARGED WITH ZINC DUST AND ARTICLES TO BE GALVANIZED, IS READY FOR IMMERSION IN THE FURNACE.

OIL AND AMMONIA FROM SEWAGE.

IN a paper read in London before the Institute of Mining Engineers, Mr. Marmaduke F. Purcell described a method of utilizing sewage for the production of crude oil and ammonia, together with certain experiments which had been carried out looking to this result. The author stated that in studying the question of the utilization of sludge it became obvious that it is most unsatisfactory and uneconomical to aim at the production of only one product, but that a number should be obtained in the operation. The process devised by him deals with the sludge after it has passed through the filter press or has been otherwise condensed. When the sludge has been precipitated by lime it is especially well fitted for the manufacture of cement.

London sludge so treated contains 58.06 per cent of moisture, 16.69 per cent of organic matter, and 25.25 per cent of mineral matter. The mineral matter contains 7.94 per cent carbonate of lime, 2.45 per cent free lime, 8.08 per cent silica, 3.39 per cent alumina, and small amounts of other minerals. Chemical examination indicated that the material was capable of yielding by distillation large amounts of ammonia and also an oil valuable as a carbureting material for enriching gas.

The earlier experiments indicated that the sludge must be distilled in a retort in which it could be given two or more different temperatures; at the lower of which certain elements chemically combined to form the oil vapor, and at the higher nitrogen was burned, so to speak, in an atmosphere of steam and converted into ammonia by the action of the caustic lime produced in the operation. Further experiments, he said, demonstrated that oil could be obtained which would be excellent for liquid fuel or for gasifying. The residue from the retort was a valuable material for conversion into cement. A considerable amount of incondensible gas was produced, which it was suggested could be used in drying the sludge, for which purpose also hot gas flues could be carried under especially arranged floors on which the sludge cakes would be spread. Oil, gas, and ammonia water could be produced and condensed in suitable receivers and then separated. From a number of experiments, both in the laboratory and on a larger scale, it was found that on an average from 9 to 10 gallons of oil and from 57 to 65, and in some cases 100 pounds of sulphate of

ammonia per ton were obtained. It was found necessary to dry the sludge cake until it contained not more than 15 per cent of moisture before distilling it. The author estimates that the yield of one ton of sludge should be approximately as follows: 20 gallons of crude oil, at 3 cents per gallon, 60 cents; 80 pounds of ammonia, at 3 cents per pound, $2.40; 600 pounds of residue suitable for cement, $2.40; total, $5.40. He estimates the cost of obtaining this to be: Drying, $1; distilling and producing crude oil and ammonia, $1.10; crystallizing sulphate of ammonia, including the cost of the sulphuric acid, 60 cents; total, $2.70. The author stated that he was carrying out some experiments which, if as successful as he expects, will enable him to obtain about 200 pounds of sulphate of ammonia per ton of dried cake. The oil obtained from this process is small in quantity and of so little value that its principal use would be for carbureting a portion of the gas produced, which would probably be used about the works, as in drying the sludge.—Municipal Journal and Engineer.

THE ANILINE DYES.

THEIR APPLICATION TO EVERY-DAY FIBERS FOR HOME DYEING.

BY MAX OHLMAN.

COAL tar is a black pitch-like mass, the mother substance of the beautiful anilines. Such is one of the marvels of the science of chemistry. Thus from black, inert coal we derive more than 95 per cent of the many dazzling and brilliant shades seen on our modern silks, satins, etc., and yet those engaged in the manufacture of these dyes are always putting forth new efforts for brighter, purer, and faster colors.

Now, with only a few exceptions, the natural coloring matters are fast becoming obsolete; logwood and indigo, the last largely supplanted by the purer synthetic product from the coal-tar derivatives, alone holding their own. Thus from the first aniline dye, mauve, a violet dye discovered by Perkin in 1856, until now, when thousands of colors are on the market, the progress in their manufacture and mode of application continues.

There are now in the market enough dyes, whose method of application to the various fibers is so simple, that even those not initiated, with a reasonable amount of care, judgment, and perseverance, can produce beautiful results. Faded or stained portieres, curtains, draperies, laces, ribbons, and wearing apparel of all classes, provided their day of usefulness is not over, can be redyed similar or darker shades of nearly every hue, and often equal in every respect to the new.

To those who will thoroughly digest the matter contained in this article, the number of failures occurring in home dyeing can be reduced to a minimum.

When a professional dyer is given an article for redyeing, the first thing he does is to see what fibers the article contains, whether cotton, linen, wool, silk, or mixtures of one or more of these fibers. This is very important for the accomplishment of the best results. The ability to distinguish and identify the fibers forming the composition of a textile fabric is of inestimable value to every man, woman, and child.

There are a few mechanical and chemical tests within the reach of everyone, whereby the various fibers may be unmistakably distinguished from each other. Therefore, by identifying your fibers correctly, one source is remedied to which many failures in dyeing can be attributed.

EVERY-DAY FIBER: PHYSICAL TESTS.

The most common vegetable fibers used are ordinary cotton, mercerized cotton (often sold as American silk, mercerized silk, etc.), linen or flax, and artificial silk. Less common, but often met with, are jute, hemp, and ramie or China grass. In this article only cotton, linen, and artificial silk will be discussed under the fibers of vegetable origin. Wool and silk are the most commonly met animal fibers. Fur, feathers, leather, tussah or wild silk, and hair are usually out of the domain of the home dyer.

Now the basis of the methods of differentiating between the two classes of fibers, as classes, depends on the similar properties of all the vegetable as contrasted with the properties of the animal fibers. All the vegetable fibers are essentially cellulose, that is, a compound of carbon, hydrogen, and oxygen. They burn brightly, char, and smell slightly as of burning wood, and leave a grayish ash.

The animal fibers, silk and wool, contain nitrogen in addition to the above elements, so that on igniting or heating they fuse rather than burn, become brittle, form a black carbonaceous bead or residue, and have an odor like burning feathers or hair. Wool contains also a small amount of sulphur, which renders it easily distinguished from silk by simple chemical tests.

Hence, if we have a piece of cloth and wish to find out by mechanical means if it is all wool or contains say cotton, separate some of the long threads composing the warp and some of those that run crosswise and compose the filling, unravel each of these independent ones with a needle or pin, and ignite each thread. Having first noted how a cotton thread and wool or silk burns, we very often need investigate no further. Thus also artificial silk and mercerized cotton can be distinguished from true silk.

But some union goods (goods composed of mixed fibers) are so cleverly interwoven or carded together, that they require chemical tests to be sure of their composition, or to at least verify any doubt left after the burning test.

I shall give here a few tests that can be performed without experience, and with a few cents worth of common chemicals, which can be bought from any supply house or drug store. Of course, the chemicals are to be kept properly labeled, out of the reach of children, and not in the medicine chest.

EVERY-DAY FIBERS: SIMPLE CHEMICAL TESTS.

The simplest chemical distinction between the vegetable and animal fibers depends on the fact that the strong alkalies dissolve wool and silk and do not affect the vegetable fibers. Therefore, if by boiling a piece of cloth in a strong solution of caustic soda or potash (about one part alkali to ten parts of water) it dissolves completely, it is all wool or silk. If any residue remains, wash well and dry. This residue is a vegetable fiber, probably cotton.

If it is silk, and we wish to know if it contains any wool, add to the hot dissolved alkaline solution of the fiber some lead acetate (sugar of lead). If wool is present, it becomes dark brown or black by reason of the formation of lead sulphide (union of the lead with the sulphur of the wool).

Now just the reverse action takes place with acids. If a piece of cloth containing animal and vegetable fibers in combination is immersed in a moderately strong solution of either sulphuric, nitric, or hydrochloric acid, and dried for some time at 110 deg. F., the vegetable fibers can be beaten out as a dust. The wool and silk remain intact. The acid must not be too concentrated.

Another simple method by which to detect the animal from the vegetable fiber in mixed goods, consists in dyeing with a small amount of acid, then boiling a few minutes, and washing well with a color which only dyes wool or the animal fiber. Picric acid and a number of acid colors (that is, colors whose coloring power is only fully developed with the aid of acid) dye only the wool or silk, and leave the vegetable fiber uncolored.

Now for a few simple tests to distinguish cotton from linen or mixtures of the two. (1) Immerse the threads in pure olive oil. The cotton remains opaque, the linen semi-transparent. (2) Treat the mixture of cotton and linen with a solution of caustic soda (1 to 16). The flax becomes more curly, and is dyed yellow to orange. Cotton turns a grayish white (Kuhlman method). (3) The mixture is boiled in water, dried, and dipped in a strong solution of salt and sugar. The fiber is ignited. Cotton leaves a black, and linen a gray ash (Chevalier's method).

Artificial silk (cellulose silk, gelatin silk, etc.), largely used in braids, tassels, etc., may be distinguished from real silk not only by its superior glassy luster, but also by the burning test, and by moistening with hot water, it being very much weaker than real silk. Therefore, in dyeing artificial silk no high temperature must be employed or the fiber will disintegrate. True silk may be distinguished from wild tussah silk, as it dissolves much more readily in caustic soda.

COLOR BLENDING, HARMONY, ETC.

In dyeing, red, yellow, and blue are considered the primary colors, that is, they cannot be subdivided into other colors. These colors will give the entire range of the rainbow when properly combined, viz.:

(1) Red—reddish yellow.
(Orange).
(2) Yellow—yellowish green.
Green—greenish blue.
(3) Blue—reddish blue.
(Indigo).
Violet.

Thus red can be mixed with yellow and blue, but not with green, for we can understand a bluish red or a yellowish red, but not a greenish red. Therefore, we cannot dye a green on a red, as one would kill the life of the other and produce a somber hue, bordering between a dirty brown and black. All shades between white and black compose the tones of grays. So all the primary colors and their mixtures with gray or black afford an unlimited number of shades. The above should now enable us to comprehend which colors can be dyed upon other colors, provided not much of the original color can be removed by a preliminary stripping.

If the original color is white, any color can be dyed on it.

Reds can be dyed a darker red, crimson, wine, very dark navy, dark brown, or black.

Orange can be dyed darker orange, olive, red, brown, or black.

Yellow can be dyed darker yellow, olive, green, orange, red, brown, or black.

Green can be dyed darker green, olive, olive brown, or black.

Blue can be dyed darker blue, navy, plum, dark brown, dark green, or black.

Violet can be dyed darker violet, plum, olive green, or black.

Brown can be dyed darker brown, wine, or black.

Grays can be dyed darker grays, wine, maroon, navy blue, dark blue, dark green, brown or black (lavender, pink, rose, baby blue, or drab).

Cream can be dyed any darker shade of similar character.

Whenever a color does not turn out the right shade, if it cannot be dyed any similar or darker shade, black is always the last resort. If it were a red or other shade with a very reddish hue, in dyeing black remember to put in green in proportion to overcome the reddish cast, that otherwise would give the black a rusty tone.

Sound judgment must be used in combining shades. You cannot dye a light shade over a darker one without first stripping, nor a brighter shade over a dull one, as a pink, cream, or baby blue, over gray, etc.

When mixing two or more colors, one can get a rough idea of how the mixture will appear by applying a few drops of the same to filter or white blotting paper; but if the goods already have a color, this must be taken into consideration; namely, if your goods are medium blue, and you should wish to dye them medium green, use only a very little or no blue, but enough yellow necessary to bring the desired green. If for a dark green, add both blue and yellow or orange.

Before we consider the dyeing, a list of colors that harmonize may not be out of place.

Scarlet with gray, brown, green, black, tan.

Cardinal with dark green, tan, gray, black, brown, marine blue.

Maroon with orange, yellow, green, black.

Pink with baby blue, light gray, light green, tan.

Cream with lilac, baby blue, Alice blue, Copenhagen blue.

Yellow with violet, navy blue, green, black.

Orange with white, violet, navy blue, black, maroon, dark brown.

Black with yellow, orange, red.

Green with scarlet, maroon, rose, black, and violet.

Dark green with cardinal, scarlet.

Gray with heliotrope, lilac, scarlet, red, cardinal, yellow, brown, pink, violet, navy blue.

Baby blue with cream, tan, gray, light yellow, pink.

Navy blue with yellow, orange, tan.

Dark brown with scarlet, cardinal, orange, blue, heliotrope, violet.

Tan with navy blue, cardinal, scarlet, pink, baby blue.

Heliotrope with tan, gray, yellow, green, black, cream.

Violet with white, orange, yellow, brown, green.

Opposite colors harmonize best, as red and green, yellow and violet, orange and blue, and the non-colors black and white.

FASTNESS, PROPERTIES, AND CLASSES OF COLORS.

No one color is fast to all influences, generally speaking. Fastness generally implies the use for which the fabric or color is intended. Thus, cotton fabrics should stand washing with soap water better than costly silk materials, which should only be dry-cleaned. Underwear and hosiery require colors fast to washing and perspiration; fastness to light is not of much consequence. Rich silk dresses, that are seldom used except for social affairs, balls, and rare occasions, do not require the fastness demanded for hats, uniforms, etc., which usually must stand sunlight and all kinds of weather.

The commercial envelop dyes, sold for home use, are generally fast enough for ordinary purposes; some of the colors, of course, being faster than other shades. The light shades, as a rule, fade faster than the darker ones.

While the mill dyer and expert has about eight or more classes of colors from which to choose, and some very complicated processes to meet for extraordinary requirements, the home dyer has only two classes of colors from which to make a choice. These are known to the trade as the direct or substantive colors, for vegetable fibers (which also include colors adopted for unions, mixed fibers) and that class known as acid colors, which are only for use on all animal fibers.

Aside from giving some information as to the properties of these two classes of colors, I shall leave their choice entirely to the discretion of the buyer.

The direct colors are dyed only with the addition of common salt on all classes of vegetable fibers. A great many of these direct colors have an affinity also for wool and silk, some dyeing at a boil in mixed goods, the cotton or vegetable fiber darker, others dyeing the wool or silk darker. These two properties, by being combined correctly by the color expert in the laboratory, in connection with some of the acid colors, which add brightness to the wool in neutral salt baths, give very good union combinations. These direct colors are used principally for cotton and vegetable fiber dyeing, and where there is a mixture of cotton and wool, or cotton and silk.

Naturally, if these colors dye the wool and silk in mixed goods, full shades, they will dye them alone, and may be so used if one desires.

Now that class of colors known as acid colors dye only the animal fibers full shades with the aid of acids, such as sulphuric or acetic acid (vinegar). Glauber salt (sulphate of sodium) is usually used along with the acid to act as a restrainer; namely, to prevent the acid springing the color too fast. This class of colors leaves the vegetable fibers white or only slightly stained. They are accordingly only used for pure woolens and silks. They dye very bright, pure shades, level well, and do not affect the feel or luster of the fiber.

Some of the direct colors before mentioned also give some bright, fast, level shades on wool and silk, and are to be used always whenever there is any doubt as to whether the fiber is all wool or all silk. Otherwise, the choice is left with the user, remembering when using the acid colors that they are used for animal fibers only.

PRELIMINARIES TO DYEING: CLEANING AND STRIPPING.

The first thing to be done is to have all garments and wearing apparel free from grease that are to be redyed. Grease spots can be taken out best with benzine and afterward washed with warm soap suds and rinsed well.

Another excellent plan is to soak the garments for about one-half hour in hot water, made alkaline with sufficient ammonia to give the ammonia odor to the water. Turn occasionally and rinse well.

It is advantageous that all colors should be discharged from goods by different changes of boiling water, so that the new color is not contaminated by the old one. The ammonia water stripping mentioned above usually brings considerable color out of woolens and silk.

All cotton and vegetable fibers may be better stripped by boiling out with strong soap solutions. Sometimes washing soda, not cooking soda, is advantageously used with the soap, and the fibers again boiled in fresh water and rinsed well. Never boil wool and silk with soda. Castile or any white soap can be used at a hand heat in scouring wool. Silk may be boiled with a good soap in stripping.

DYEING: PRECAUTIONS TO BE OBSERVED.

(1) Use vessels large enough for the proper manipulation of the goods. These may be either agate, granite, porcelain lined, or bright copper. Bright tin wash boilers even can be used for direct salt colors. Some small dyers use stout wooden barrels with perforated steam pipes in the bottom.

(2) Have your dye previously completely dissolved before entering the same in the dye vessels, and always lift goods out when adding the dyestuff.

(3) Correct very hard water. This can be done on a small scale by boiling with good white soap, one-half ounce to two gallons of water, and skimming off the scum arising to the surface.

(4) Never enter the goods into the dye liquor, except after they have been evenly boiled or wet out. Wring carefully, or drain off the excess of water, and always allow for the increase in liquor of the dye bath necessary on entering the wet goods.

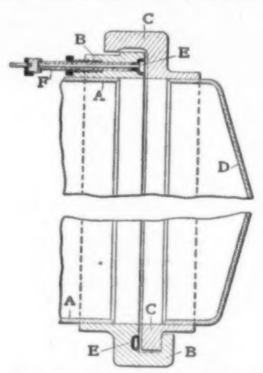
(5) Use approximately about twenty times the amount of water of the weight of the dry goods. Wool and silk, when using acid colors, require about double this amount of water. Calculate about 8 1/3 pounds of water to a gallon. Therefore, for direct colors, one pound of cotton requires about $2\frac{1}{2}$ gallons of water. Usually the more concentrated the dye liquor, the heavier the shade, especially with the direct salt colors. Light shades had better be dyed in a large volume of liquor.

(6) For stirring the goods, use smooth, round sticks, such as clean broom handles or large glass rods; nothing pointed, that might tear the goods, should be used.

(7) Turn the goods gently, completely, and with absolute regularity. Many of the uneven results often obtained occur through poor manipulation. This is one of the most important operations in dyeing.

(8) Do not rush the dyeing because the shade looks beautiful or deep enough. Full shades usually require about an hour's boiling. All colors appear much darker while wet, and cotton dries out two or three shades lighter. Preferably, if possible, dye along a sample of the same goods attached to a string, whereby a small piece may be taken out from time to time, and dried for comparison.

(9) For light shades, always start off with a small amount of color, and after say 15 or 20 minutes boiling, lift out and dry a small piece. If too light, enter and boil again with more color. After much experience, one can judge the progress of a dyeing



WATER-TIGHT CLOSURE FOR VATS.

fairly well by simply squeezing out an excess of color from a part.

(10) Remember that thick and hard-twisted yarns and goods require longer boiling than soft, open goods; also all articles must be well washed in many changes of water after the dyeing or until free from color, otherwise the color may crock or rub into the undergarments or skin.

(11) Always weigh your goods while dry, as the lightness or darkness of the shade on a given amount of color depends on the weight of the goods.

(12) Always squeeze well after the last washing and dry in the shade.

(13) Never dye a light color in a vessel which has had a dark color in it, without first cleaning same thoroughly. Sand soap or sapolio usually suffices to clean the vessels.

DYEING METHODS: GENERAL.

Cotton.—Enter warm, bring gradually to the boil, and boil one hour; use from 5 per cent to 25 per cent salt of the weight of the goods according to the depth of the shade required. Light shades and very hard materials had better be boiled in the color alone about 20 minutes and then add the salt. This obviates almost all chances of uneven results, but of course the goods must be turned properly, nevertheless. The salt gives density to the bath and fixes the color.

Mercerized Cotton.—Dye the same as ordinary cotton, but as it has an increased affinity for the color, it requires about 25 per cent less color for the same depth of shade.

Linen.—The same method as cotton.

Artificial Silk.—Dye the same as cotton, but do not raise the temperature above 140 deg. and manipulate carefully.

Union Goods.—Composed of part vegetable fiber as cotton, and part animal fiber as wool. Enter slightly warm with the proper amount of salt and color. Raise to the boil in one-half hour, boil one-half hour, and cool down in the dye bath. Should the wool be heavier than the cotton, remove it from the fire, add a little more color, and let the cotton absorb the color in the cooling bath. When there is a difference in the depth of the color on cotton and wool in union dyeing, usually long boiling makes the wool heavier. Therefore, boil a shorter period, or take a longer time in bringing it to the boil. Often in a wet union dyeing, the cotton and wool appear to be the same depth until dry, when the cotton may appear lighter, therefore cotton should appear deeper in shade while wet than the wool.

Wool and Silk.—If dyeing with the direct colors, dye as cotton. If using the livelier acid colors, enter the material warm with sufficient sulphuric acid (1 to 4 per cent of weight of goods) or acetic acid or vinegar (3 to 10 per cent) and Glauber salt (10 to 15 per cent). For lighter shades always use proportionately less amounts of acid than for the darker ones. Bring slowly to the boil, and boil 30 minutes to one hour. These colors usually exhaust thoroughly, leaving the bath colorless.

As with cotton, light shades and thick materials may be dyed better by using Glauber salts alone, and boiling 20 or 30 minutes, cooling down the bath, adding acid, and boil again to exhaust. Even shades and good penetration thus occur where otherwise the acid alone may spring the color too quickly.

DYEING: GENERAL INFORMATION.

Overdyed or bronzed shades may often be corrected by stripping off excess color in a boiling soap bath and washing well.

If some goods have been dyed with acid colors, and cotton threads show through white, redye the cotton threads at a low temperature (as boiling will also drive much color on the wool) with about the same shade of a direct salt color, regulating the amount of the dye proportionately to the amount of the cotton to be covered.

Often cheap silk, which is heavily weighted with tin salts as well as with other chemicals, has to be redyed, and frequently it tenders or rots. This is usually blamed on the dyeing, but such is not the case, as pure silk is never tendered in proper dyeing. Therefore, a small piece may be tested before dyeing, to find its strength.

Fold a small piece of the dry material in both the direction of the warp and the weft or filling, press the creases hard with the finger nail, or cold iron, and try its strength by moderate stretching and pulling. If it tears in the crease it must be very gently handled in the dyeing. This test is still more thorough if the material be boiled previously in a strong soap solution. Soap does not injure good silk fiber.

All dyeing should be done at a gentle boil. Hard boiling offers no advantage generally, and has more tendency to felt wool and bundle or knot silk.

In dyeing gloria (this is wool and silk finely interwoven) should the wool be dyed darker during the boiling, the silk shade often can be brought up to the wool by adding fresh color to the cooling bath at about hand heat, and letting the silk dye in the cooling bath, turning the goods regularly.

White or light colored cotton and woolen mixed goods may be dyed "shot effects" (two colors) by dyeing the wool, say with an acid red, acid, and Glauber salt, the usual way and washing well, and dyeing the cotton in a fresh bath, say green, with a direct salt color at a low temperature (about 120 deg. F.). High temperature would drive some of the color on the wool, and dull the contrast of the two-colored effect.

Home dyeing, generally speaking, is quite a simple operation; and if the home dyer will only use good judgment, and observe carefully the precautions given above, failures will rarely occur.

It is better to first begin dyeing cheap cotton or woolen goods, and later, after one gains more experience and confidence, to dye more costly fabrics.

WATER-TIGHT CLOSING ARRANGEMENT FOR STEAM-VAT BOTTOMS.

THE bottom of the cylinder here shown has an arrangement for a quick and water-tight closing, the use of which should be advantageous for cooking by steam, say in canneries or packing houses.

Instead of the ordinary flange with hinge and bolt, to insure a tight bond between vat and bottom, the cylinder *A* and its bottom *D* are each provided with cast-steel rings *B* and *C*, which both have on one of their halves a groove, on the other a rim. These rings are so arranged that by displacing them laterally the rim of one ring fits into the groove of the other. The pressure exerted by the contents of the cylinders transmits itself normally to the contact surface of joints. The water-tightness of the joint is furthermore increased by an annular lead pipe *E*, lodged into a groove of the ring *B*, and into which pipe oil is forced under high pressure through the valve *F*.

The cylinder *A* is very easily opened by letting out the oil in the pipe *E*, then lifting the ring *C* and the bottom *D* perpendicularly to the axis of the cylinder.
—Génie Civil.

THE INTERNALLY-FIRED HELICAL FURNACE.

WHOLESALE ANNEALING AND HARDENING DONE ALMOST AUTOMATICALLY.

BY C. M. RIPLEY.

UNIFORMITY of heating of material in manufacture, if heating is at all necessary, is probably the most important operation to which the material is subjected, and has more influence to make or lose money for the manufacturer than any other. In fact the success of most of the other operations depends largely on the success of this one. The good or ill effects of annealing or hardening extend to all subsequent operations upon the metal, and to the very life of the material itself.

If the pieces are brass, for instance, and must be punched, drawn, or spun, the machine which handles them will run much more easily, smoothly, and quickly without risk if they are clean and uniform in malleability. If they must be stamped or pressed, they will appear clear and distinct, and few or none will be "scrapped." If they must be buffed or polished they will work more easily and be of one color when finished. If the pieces are steel and must be hardened, they will be as hard as that particular steel will permit, and will be free from scale, easy to temper or polish if necessary, and will be strong and durable.

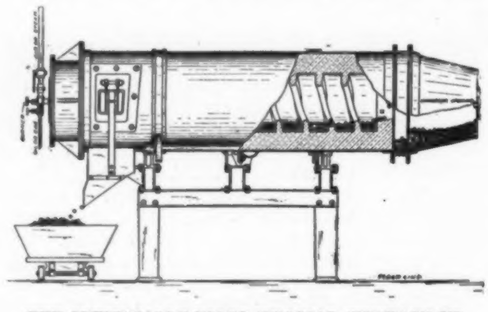
This subject of uniform heating does not always receive the attention which its importance deserves, even demands.

Every manufacturer who handles material which requires annealing or hardening to fit it for use, knows that it is best and commands the highest price when it has been properly and uniformly heated. Yet he does not always realize how easily his furnace or his fuel may defeat his best efforts; or, on the other hand, how easily these two things, if right, may help him to complete success. I say help because while the furnace and fuel are fundamental, they are not all that is necessary. His employees must be carefully instructed and they must know that the heat treatment is right all the time.

Take Mr. Edison's cement furnaces for example—ten of them, 150 feet long, 9 feet internal diameter—at his cement works, New Village, N. J. Cement men said he could not successfully operate furnaces that long. Possibly he could not with their fuel and their methods. But he could and does with his method and his fuel—pulverized coal injected with a jet of compressed air at 80 pounds pressure. The old furnaces were too short; so he made long ones. The coal was not suitable in its natural condition; so he pulverized it. He permitted nothing to stand in his way. He made the furnace and fuel do what he wanted them to do—produce 8,000 barrels of the finest grade of Portland cement every day.

And so the internally-fired helical furnace has been made to do what other furnaces and other fuels cannot do successfully.

Much annealing and hardening is still done in old-style stationary furnaces, and owing to the size and shape of much of the material it must continue in that way, whatever the inconvenience and expense. Where size and shape have permitted, some work has been and is being done in rotating cylinders heated from the exterior. Such cylinders are generally made of cast iron, and it is obvious that the life of the



THE INTERNALLY-FIRED HELICAL FURNACE IN PARTIAL SECTION.

iron is too short to be satisfactory for many purposes, especially for the heating of steel. It is also obvious that the cylinder cannot conduct the heat to the material as economically as a direct application. Tumbling barrel furnaces and bucket and chain conveyer furnaces have been used for certain low-temperature work, each kind having its limits as to durability and efficiency, and each suggesting at once a protest against earlier and cruder methods as well as a hope for better ones to follow.

In this country alone there are millions of small equal-size bits of valuable material in brass, copper, steel, aluminium, gold, silver, and other metal which must be annealed or hardened every day, such as cartridge shells, ferrules, eyelets, buttons, caps, cups, coin blanks, steel balls, saw teeth, tacks, screws, rivets, rings, springs, nuts, punchings, etc., and it was only natural that the internally-fired helical furnace, made by the W. S. Rockwell Company (New York) and here described and illustrated, should have been designed to heat these pieces in a practically ideal and wholesale fashion.

As will be readily understood from the illustrations the furnace is formed of a steel cylinder, with a smooth fire tile lining of helical form, and is rotated upon rollers supported by a suitable iron frame. The power may be furnished from a line shaft or from a motor suitably controlled. Ordinarily the speed is from one to three revolutions per minute, and the time of travel through the furnace from 3 to 10 minutes. Either oil or gas may be used as fuel, which is injected directly into the chamber in the opposite direction to that of the travel of the material. Combustion is complete and the spent gases find vent where the material enters—giving up their heat to the incoming material as they pass, in the spirit of true economy. Not only is the heat thus saved but the material is thereby heated up in that gradual manner which is best for it. The material is charged into the feed-drum in bulk and is then wormed through the furnace at a perfectly uniform and positive speed. The time and temperature for every piece is absolute. Starting cold the material winds its way through the convolutions of the furnace for a distance of about 47 feet, ever tumbling over itself, ever on a new hot surface, ever in the direct heat, yet reaching its ultimate heat only at the very point of discharge, where a pyrometer is located to show exactly what that ultimate heat is. Such heating is ideal, especially for hardening steel which should enter the bath at its rising hardening temperature. This action is important, also, in preventing or reducing oxidation.

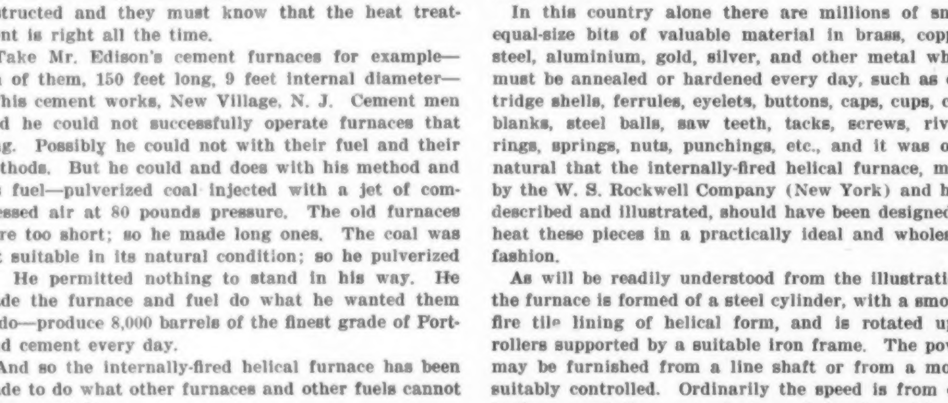
Each piece is exactly right, and the day's output is all the same. For example, a lot of 15,732 pieces of steel was run through one of the furnaces here shown and hardened in oil, and each piece was then carefully tested. Only two were found imperfect, and they from flaws in the steel itself, not from the heat. The manufacturer stated that such runs were the rule, not the exception. Again, material annealed in this type of furnace in 6½ minutes was found to be cleaner and better in every way than the same material annealed for 45 minutes in a tumbling barrel type of furnace. This would seem to prove that protection from oxidation and saving of time are both effected when the material is heated up gradually, never overheated, and discharged the moment it has reached its ultimate temperature.

When the furnace was used for hardening, a quenching tank with a conveyer was provided below the discharge spout so that the material after immersion was automatically removed from the bath quite clean and delivered into a truck or wheelbarrow. Provision was made so that two kinds of material could not become mixed, nor could any lodge in any part of the furnace or bath. By the simple removal of two bolts the conveyer could be easily removed from the bath, giving free access to every part thereof for cleaning or other purpose.

The furnace requires no chimney, but a hood to carry off fumes from the oil bath or from machine oil on the material is sometimes desirable.

Either air or dry steam may be used to inject the oil or gas fuel. Coal or coke fuel cannot be used.

One of the chief features of the internally-fired helical furnace is its durability. Practically all the iron work is out of range of the fire, and all the parts are simple and strong.



THE FURNACE READY FOR OPERATION.

THE INTERNALLY-FIRED HELICAL FURNACE.

FENDERS AND WHEELGUARDS.

THE report of the fender and wheelguard tests conducted last fall at Schenectady and East Pittsburg by the Public Service Commission of New York, first district, have been published. At the time they were being made these tests attracted much attention from manufacturers of devices and railway managers not only in the United States, but in foreign countries as well, and the full report, made public recently, will no doubt have wide circulation. It is certainly deserving of the most careful study and consideration, for nothing approaching these tests in the matter of reproduction of operating conditions and thoroughness has ever been attempted by any commission or railway company in an effort to find practical and efficient life-saving devices.

Some features of the report, perhaps, need explanation to make clear the purposes and methods of the commission in carrying out the tests and in rating the efficiency of the many devices submitted. Its purpose was to determine by actual trial with lay figures the essential and necessary features of operation and construction of life-saving devices suitable for application to cars operating under the conditions obtaining in the city of New York. While the ratings given to the devices named in the report are to some extent an indication of their general efficiency based on their performance under test, the commission does not necessarily condemn the devices tested which did not attain a mark of over 75 per cent, nor does it imply that only the apparatus named in its preferred

list will be considered in the future for possible use in New York. Some of the devices included in the preferred list are, in fact, considered by the commission to be unsuitable for application to cars operating under the conditions met with in New York. In case the commission should promulgate an order requiring the surface lines within its jurisdiction to adopt fenders and wheelguards, in accordance with the recommendations contained in the report, the companies will be allowed the widest possible choice in adopting any particular type. The commission has also defined its position with regard to including in its preferred list devices which failed to meet the requirements in the tests conducted last fall or types which were not submitted for test. On an application involving this point the commission has decided to conduct other tests at its own expense or at the expense of inventors or manufacturers, purely for experimental purposes. If the manufacturer of a device which meets with the approval of any of the railway companies in New York city will have a device applied to one of the company's cars, an inspector of the commission will pass upon it, and if it meets the general requirements, opportunity will be afforded for conducting a test under conditions exactly similar to those of the Schenectady tests. The expense of these tests, however, must be borne by the manufacturers. If a device successfully passes such a test, it will be included on the preferred list. As a result of its experience, the commission is now in a position to know what is required of a fender and wheelguard, and can probably judge fairly well whether or not a device would meet the requirements merely by an inspection; at least, no great amount of time will be wasted on utterly worthless apparatus.

It may be well to outline briefly here the methods employed by the commission in determining the ratings of the devices tested. No reference to this work is made in the body of the report published elsewhere. Each test of a fender or wheelguard was marked on a scale of unit points, ranging from four for a perfect pick-up to zero for a complete failure. The total number of points made by a fender in all of the trials to which it was submitted were reduced to a percentage of the total points possible to be made in these tests. This percentage was averaged for both kinds of pavement and both speeds for each of the 50-pound, 120-pound, and 170-pound dummies. The average percentage of efficiency was obtained by adding to the average percentage made with the boy and man dummies twice the percentage obtained with the woman dummy, and dividing the sum by three. This figure represents the relative efficiency or life-saving qualities of the various devices, based on the actual number of tests made with them, and not on their performance as gaged by a perfect performance in the entire series of tests required. It may be argued that many of the devices were subjected to only a few trials, while others were given nearly all of the trials included in the programme. Many of the devices became inoperative after a few trials with the 50-pound dummy. Time would not permit their repair or the substitution of other apparatus of the same type for continuing the tests. In general, failure to stand up for more than a few trials is reflected in the rating factor of maintenance which enters into the determination of the final ratings given in the report.

The calculation of the final ratings involved consideration of the percentages of efficiency, maintenance, material, number of parts and weight of the devices. The rating factors for maintenance, material, number of parts and weight were determined by comparing each device with an assumed standard of 100 per cent based on a careful study of the average properties of a number of standard life-saving devices in general use by street railways in all parts of the United States.

The percentage factor of efficiency was multiplied by four, maintenance by three, the material factor by one, the number-of-parts factor by one, and the weight factor by one, and the sum of these five products was divided by ten to obtain the final rating. It will be seen from this that the efficiency and maintenance factors were the controlling elements in determining the final rating.

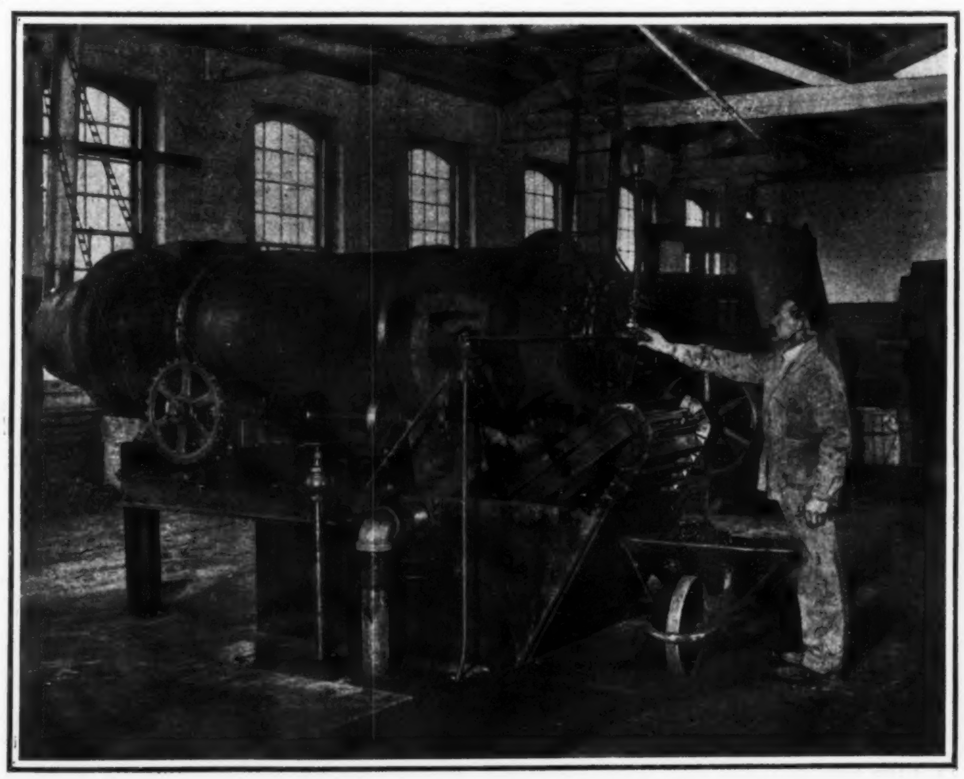
The commission believes that the many trials made have given it definite and conclusive data on the question of efficiency. Almost equally important, in the opinion of the commission, is the question of maintenance of these devices. This point is clearly brought out in the body of the report. Life-saving devices are of little or no value unless maintained in perfect operating condition at all times. The result of negligence in this particular is too often a costly damage suit, which might have been prevented, or at least the amount of damages greatly reduced, had the life-saving device on the car been in perfect operating condition. It is true that many of the fenders on the market are expensive to maintain and are easily put out of operation, but this fact ought to be understood by the manager before he buys such devices. The report under consideration brings out strongly the importance of maintenance. It says: "It should be fully understood that the effectiveness of the recommendations [with regard to the installation of fenders and wheelguards on cars] is wholly dependent upon the maintenance of the devices in a thoroughly operative and life-saving condition."

In studying the details of the tests contained in the report it may be well to throw out a word of caution about comparing the merits of the several devices one with the other. The devices tested represented a great many radically different types and forms of construction. Some which showed efficiency in the tests were totally unsuited for application in New York. Railway managers outside of New York who may be interested in these tests should bear in mind that the consideration of such devices requires close study of their suitability for the peculiar local conditions under which they are to be used. Some of the devices, for example, are held normally only about one inch above the rail. For single-truck cars or cars operating over roughly-paved streets such devices would be out of the question. In general, it may be said that pick-up efficiency is roughly proportionate to the height at which the device is carried above the track when striking a prostrate body.

The report contains no information whatever about the detail of each individual test. The story, however, has been preserved in pictorial form by means of a series of over 1,800 photographs showing the position of the dummies after each test. These photographs are the best evidence of what the devices tested will actually accomplish. The commission was perhaps justified in not including these details in its report. The publication of all of the photographs would have been very costly, and would perhaps have been the cause of much unfair and unwarranted criticism on the part of sponsors of devices which proved unsuccessful in the tests. Just what disposition the commission will make of this mine of information which has been obtained in the shape of these photographs and other data has not yet been decided, but it is to be hoped that the commission will take a broad and humanitarian stand, and permit interested persons, either inventors or managers of railway companies, to avail themselves of the experience gained in the tests through a study of the photographs and data if they so desire. In conclusion, it may be said that the tests cannot help but prove a strong incentive to the development of more perfect life-saving devices for electric cars and their more general adoption by street railway companies.—Electrical Railway Journal.

Insulating Cement.—2 parts of Grecian pitch and 1 part of well calcined plaster are melted together. As long as the cement remains warm, it can be kneaded and worked plastically; when cold it can be worked and polished in the lathe.

CHARGING THE FURNACE.



THE FUEL-SUPPLY END OF THE FURNACE.

THE INTERNALLY-FIRED HELICAL FURNACE.

EARTHQUAKE FORECASTS.—II.*

FUTURE POSSIBILITIES.

BY G. K. GILBERT.

Continued from Supplement No. 1730, page 143.

Alternation.—The principle of alternation in the occurrence of earthquakes has already been touched. When a large amount of stored energy has been discharged in the production of a great earthquake and its after-shocks, it would seem theoretically that the next great seismic event in the same seismic district was more likely to occur at some other place, and that successive great events would be distributed with a sort of alternation through the district. This hypothesis I used twenty-five years ago, in predicting that the next slip on the fault at the base of the Wasatch range, instead of occurring in the locality of the last previous slip, would take place at a different point;† and it has been more recently applied by Omori, Hayes, and Lawson in forecasting earthquakes on the western coast of the two Americas. These geographers agree in regarding the entire coast either as a single seismic district or as a portion of a greater district, in which there is interdependence of parts. Omori pointed out that in the period of six years from 1899 to 1905 there were extensive disturbances in Alaska, Mexico, Central America, Colombia, and Ecuador; stated that the gap thus left between Alaska and Mexico had led him to anticipate an early rupture in that tract of coast; and suggested, after his first anticipation had been realized by the San Francisco earthquake, that the next disturbance might be south of the equator—where the Valparaiso earthquake soon afterward occurred.‡ Hayes, after the San Francisco and Valparaiso earthquakes, suggested Mexico as a probable locality for the next rupture; and after the earthquake which devastated the State of Guerrero in southern Mexico, made a similar suggestion as to Colombia.§ Lawson mentioned breaks in the continuity of recent demonstrations between the southern part of California and Central America, and between the northern part of California and Alaska, and suggested the probability of early visitations in Mexico and the Oregon-Washington region. In this forecast he anticipated by a few weeks the Guerrero earthquake.* Omori went farther and expressed the opinion that the Valparaiso earthquake was the final term of a series, and that the whole Pacific coast of America would be exempt for a time from *great* seismic activity. He expected for San Francisco a period of immunity of thirty to fifty years and for coastal regions from Alaska to Ecuador of twenty to thirty years.

It will be observed that this idea of a series, breaking on the American coast in the course of a few years, and followed by a comparatively long interval before the arrival of another series, an idea apparently shared by Hayes and Lawson, combines rhythm with alternation in the theory of forecasting.

Prediction and verification are the test of hypothesis, and this group of predictions—albeit tentative and advanced with judicious caution—embodying, as they do, the diverse views of independent investigators, who approach the subject from both seismologic and geologic sides, constitute a valuable contribution to seismic forecasting. The outcome in verification will have bearing not only on theories of alternation, rhythm, and rhythmic immunity, but on the order of magnitude of the seismic district within which effective mechanical interaction takes place, and also on the profounder earth problems with which the question of the ultimate cause or causes of earthquakes is involved. If it shall appear as highly probable that yieldings to crustal stress in remote parts of North America have a direct influence on the dates of similar events in South America, the primary sources of the stresses can hardly be of such local nature as the shifting of load through degradation and aggradation or the outward flow of continental excess of matter, but should be sought rather in forces tending to deform the planet as a whole.

Trigger.—The third general principle applicable to prediction is that of the trigger—or the principle involved in the parable of the last straw, which broke the camel's back. As the growing earth stress little by little approaches the limit of the resisting force there is a critical period during which a relatively small additional stress arising from some other source may precipitate the catastrophe. A number of possible sources for the additional stress are known, the influence of several has been fairly demonstrated in a statistical way, and it is on the whole probable that a large majority of earthquakes owe their precise dates to such contributory causes. Many of the precipitating factors are periodic in their character, and the times of their maxima, or other favorable phases, are known; so that, granting their influence, they serve to restrict prediction to certain epochs. They are not of primary importance in forecasting, but when the approximate date of a future earthquake shall have been learned by other means, they will serve to refine the estimate of time.

The principal known causes of periodic variation of stress are bodily tides of the earth; oceanic tides, which alternately load and unload the sea bed near the shore; the winter load of snow on parts of the land; annual and diurnal variations of atmospheric pressure; diurnal variations of barometric gradient; and the wandering of the earth's axis of rotation. The relative importance of the several influences cannot yet be indicated, but it is known that their absolute importance is not the same in all places. Three belong to the coastal belts, two to the land; and two belong to land and sea, but vary with latitude. Their relative importance in any particular locality may depend also on the direction of the slowly growing tectonic stress of the crust; for in order to be effective the temporary or adventitious stresses must be of such character as to augment the tectonic stresses. Let me illustrate this point.

The tidal sway of an oceanic basin raises and lowers the surface very little where the water is deep, but has a much greater effect on the shoals bordering coasts. The strip of sea bed following the coast is subjected twice a day to the addition of a heavy load of water, and in the intervening hours is relieved of pressure by the same amount. On the seaward side of the strip there is a gradual change in pressure, and on the landward side, just at the water edge, an abrupt change; and these pressure differences cause strains and stresses in the crust beneath. The directions of the induced strains lie in vertical planes at right angles to the coast, and are competent to increase or diminish tectonic stresses having similar directions. On the coast of Alaska near Mt. St. Elias the tectonic changes in progress include an uplift of mountains parallel to the coast, and the main tectonic stresses may be assumed to lie in vertical planes normal to the coast; so that here the oceanic tides are competent to precipitate earthquakes. But on the California coast near San Francisco, where the directions of the main tectonic stresses are horizontal and are approximately parallel to the coast, the stresses from oceanic tides may be ineffective. On the other hand the stresses created in the crust by the shifting of the axis of rotation are probably better calculated to augment tectonic stresses at San Francisco than at Mt. St. Elias.

Unfortunately the value to the forecaster of the periodic stresses is impaired by the occurrence of other transient stresses which are not periodic. The barometric gradients and extremes of pressure connected with cyclonic storms are of this class, and so are the pressure changes arising when the sea is pushed against the land or drawn from it by strong wind; and all these storm effects are at times much greater than the rhythmic changes of corresponding character. If storms are really earthquake-breeders—instead of the traditional calm, sultry, so-called "earthquake weather"—then the shocks they precipitate can be foretold only so long in advance as the storms themselves are foreknown.

The most potent of all precipitants of earthquakes is also useless to the forecaster because its action is unforeseen. It is the earthquake wave emanating from a nearby focus. The response to such an impulse follows the initial shock so closely that the two shocks are combined in a single seismic event—an earthquake with two foci, or a "double-earthquake."

Prelude.—The forecasting of earthquakes by means of prelude has nothing in common with other methods, but resembles rather the forecasting of the weather for the day by a glance at the sky in the morning. It depends upon the recognition of premonitory signs, and also, to some extent, on the recognition of the earliest phases of the event itself.

When a fracture or other parting of the rock takes place, the jar which is communicated to surrounding

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* Abstracted from Presidential address to the American Association of Geographers.

† Monograph I., U. S. Geological Survey, p. 362.

‡ In an interview published by the San Francisco Bulletin of June 13, 1906, F. Omori says: "Between 1899 and January 1 of this year (1906) there have been several extensive earthquakes along the coast of Alaska, Mexico, Central America, Colombia and Ecuador. These disturbances are not to be regarded as separate or unconnected phenomena, but were the result of great stress which was taking place all along the west coast of North and South America. The Pacific slope of the United States remained comparatively quiet all this time, so it was most natural to expect a continuation of the disturbance in these parts.

"As it has finally happened this time I believe it is over and the adjustment complete. . . .

"The center of a future earthquake, due perhaps to the same causes as this, will probably be different, and may take place as far away as the other side of the equator."

In a bulletin of the Imperial Earthquake Investigation Committee of Japan, published in January, 1907, Vol. I., pp. 21 and 23, he continues the subject, illustrating the distribution of seismic disturbances by a map, and concludes thus:

"The great stresses going on along the whole Pacific coast of America, which thus resulted in the occurrence of a series of great earthquakes, seem to be connected with the growth of the Rocky and Andes mountain ranges, the Valparaiso earthquake bringing probably the great seismic activity along the zone under consideration for the time to an end."

The forecast of an earthquake between Alaska and Mexico was verified by the California shock of 1906 and the forecast of a disturbance south of the equator by the Valparaiso earthquake of 1906. The forecast of immunity for some decades in the Mexico-Central America group was shown to be erroneous by the Mexican earthquake of 1907. The success or failure of the prediction of immunity for other parts of the coast remains to be determined. It is to be noted (1) that the Mexican earthquake, occurring in a district for which Omori predicted immunity, was forecast by both Hayes and Lawson; (2) that Lawson forecasts disturbance in a region north of California for which Omori forecasts immunity, and that Hayes forecasts disturbance for a region south of Mexico for which Omori forecasts immunity. See the following notes.

§ C. W. Hayes is thus reported in the Washington Times of April 16, 1907:

"At least one man, who has studied seismic disturbances, has succeeded in predicting the locality of an earthquake months before the shock occurred.

"He is Dr. Charles Willard Hayes, of the United States Geological Survey, who made a report for the government on seismic conditions in Nicaragua in 1899. In this report he made the statement after the recent destructive earthquake at Valparaiso that he would not be surprised if the next section of the American continent to be visited by a seismic disturbance would be somewhere between San Francisco and Valparaiso, probably in Mexico.

"Dr. Hayes would not be surprised if the next earthquake should occur in the United States of Colombia, South America.

"In speaking of the earthquake in Mexico yesterday Dr. Hayes said to a Times reporter this morning:

"'While it is impossible to predict with any accuracy the location and time of the occurrence of an earthquake, our knowledge of the geological structure of the earth enables us to determine within certain limits the probable areas where seismic disturbances are most likely to occur. The course of these disturbances may be expected to follow a general line of adjustment of the earth's crust along the western slope of the two American continents, the line being somewhat broken in Central America.

"'The course from South America extends north to the islands in the Caribbean Sea, and that from North America is traceable down through Mexico and Central America. This course extends north along the coast of Alaska across the Aleutian Islands, down the Siberian coast, through Japan and thence across the Indian Ocean.

"'The disturbance in Alaska a few years ago was the first of the series that has afflicted the western hemisphere recently. It was natural to expect the next one at some distance, and, as it happened, this occurred at San Francisco. Then the Valparaiso disturbance being so far to the south it was probable that the next shake would be somewhere between the two. The shock at Jamaica was probably connected with the Valparaiso earthquake, being in the same course with it. That in Mexico is more likely to be connected with the course of disturbance from Alaska down.'

"Dr. Hayes, when asked if he would venture to predict the locality in which the next earthquake might occur, said that he did not wish to go on record as making any prediction on a matter concerning which scientific knowledge was so limited, but was of opinion that it would not be unreasonable to look for one in northern South America in the United States of Colombia. Asked whether a disturbance there would be likely to affect the region of the Panama canal, he thought that Panama might feel tremors from a considerable shock, but that it was unlikely any damage would result."

* A. C. Lawson, in a lecture read to the National Geographic Society, March 29, 1907, attributed the California earthquake to a series of ruptures that had been traveling along the western coast of America. "So far it has occurred everywhere along the coast except in a stretch between the southern part of California and Central America and an area between the northern part of California and the southern part of Alaska. These stretches, I believe, will be visited before long and then the long line of this earthquake will be complete from Chili to Alaska." This statement preceded by a few weeks the occurrence of the Guerrero earthquake in Mexico, and its prognostication was thus promptly verified as to the district south of California. It awaits verification for the district north of California.

portions of the crust is not a simple impulse, but a congeries of vibrations differing in amplitude and period, and in speed of transmission. At any point of the focus they begin together, but traveling through the rock at different rates, they arrive at any distant point at different times; and the greater the distance the greater their separation. The strongest of the vibrations, or those said to constitute the principal shock, are not the first to arrive, but are preceded by vibrations which are much weaker, and are known as the preliminary tremors. At a point twenty miles from the origin the preliminary tremors are felt four or five seconds before the principal shock. There are also vibrations too minute to be felt, and not yet recorded by the most delicate seismographs, but of such frequency that they fall within the register of the ear and are perceived as sounds, and these usually begin to arrive before the preliminary tremors. The sounds and faint tremors are notes of warning, and to him who not only hears and feels but understands they give command of precious seconds. People who live in earthquake countries and are familiar with these warnings acquire the habit of instantly taking precautionary measures.

Still earlier than the sounds and tremors with which the earthquake begins, are sometimes sounds, tremors, or minor shocks, and it is suspected that phenomena of this sort may betray growing seismic activity and thus constitute premonitory symptoms of the final rupture. Little is known of them in any exact way, because they occur at a time when attention is not directed to such matters, and nearly all records are made from memory after the occurrence of the earthquake. If they are veritable preludes, connected in a systematic way with the mechanics of the earthquake, they are probably analogous to the cracklings and crepitations observed in strained beams and strained blocks of rock before collapse occurs. With reference to the possibilities of forecasting, expectation centers especially on faint tremors such as are occasionally perceived a few minutes or a few hours before an earthquake shock. They are more frequently inferred from the peculiar behavior of animals; and after making much allowance for the influence of imagination on the memory of observers, there is still reason to think that various animals are affected by vibrations to which man is insensible, and that their reported uneasiness before earthquake shocks is real and is occasioned by premonitory vibrations.

The scientific study of preludes belongs to the future, and especially to such adaptations of seismographic appliances and methods as we may confidently anticipate. Feeble tremors, ascribed to minute crepitations of the crust, have already been made audible by means of the microphone, so that the ear could be applied to a sort of seismic stethoscope; and the next step will perhaps be to construct a seismograph of such delicacy as to record these minute vibrations, and install it where it will be undisturbed by tremors of artificial origin.

RÉSUMÉ.

Summarizing briefly, many of the malloseismic districts or areas of earthquake danger are known from records of past experience, and others are being recognized by physiographic characters. Within them are tracts of special instability because of the incoherence of the underlying formation, and these can be both characterized in general terms and locally mapped. The general relations of danger to place are so well understood that an early solution of their outstanding problems may be assumed. Of the relations of danger to time much less is known and there is less promise for the immediate future. The hypothesis of rhythmic recurrence has no sure support from observation, and is not in working order for either large or small areas. Its corollary of local immunity after local disaster is more alluring than safe. The allied hypothesis of alternation between parts of a district is being tested by a great example, but the verdict belongs to the future. The hypothesis of precipitation by accessory forces which are in large part periodic and foreknown, has a good status and is being developed on the statistical side. It promises to make the date of prediction more precise if ever the approximate time shall be achieved by other means. The hypothesis of an intelligible prelude has barely been broached and the means to test it are not yet in sight. In a word the determination of danger districts and danger spots belongs to the past, the present, and the near future; the determination of times of danger belongs to the indefinite future. The one lies largely within the domain of accomplishment; the other still lingers in that of endeavor and hope.

We may congratulate ourselves that it is not the place factor which lags behind, for knowledge of place has far more practical value than knowledge of time. In fact I see little practical value in any quality of time precision attainable along lines of achievement now seen to be open. Suppose, for example, that a prediction based on rhythm or alternation should indicate an earthquake as due in a certain year, and that tides should be recognized as the most potent accessory cause; then for several days each month, and possibly for many months, expectation would be tense, and the cost in anticipatory terror would be great. Or suppose that prelude phenomena should be found to afford real warning; the forecaster on duty would still have to deal in probabilities, and when in doubt would often sound vain warnings, in the conscientious effort to escape the greater error of omission at the critical time—and again nervous strain would be wasted. And even if warning were definite, timely, and infallible, so that peril of life could be altogether avoided, property peril would still remain unless construction had been earthquake-proof. If, on the other hand, the places of peril are definitely known, even though the dates are indefinite, wise construction will take all necessary precautions, and the earthquake-proof house not only will insure itself but will practically insure its inmates.

(To be continued.)

URANIUM MINING.

HOW RADIUM IS OBTAINED FROM THE ORE.

THE recent announcement of the success attending the application of radium in medicine by Sir Frederick Treves, the eminent English surgeon, coupled with the foundation of a British Radium Institute, will lead to an increased demand for the precious metal. The supply of the raw material, pitchblende, from which radium is obtained is practically restricted to Austria, the government of which a short time ago placed an embargo upon the exportation of the ore. The center of the Austrian industry is on the southern slopes of the Erzgebirge, in Bohemia.

The district first came into prominence through the extensive silver mines which existed there, but the industry has long fallen into desuetude. Even the uranium mining languished somewhat until the discovery of radium, when a new lease of life was imparted to it, and now, owing to governmental interest therein, it is once more becoming an increasingly prosperous district.

From this area the whole of the uranium for the world is practically obtained. In 1906 the production was sixteen metric tons, representing a value of about $55,000. As may be gathered from the high price per ton which this output represents, the ore obtained is very rich, the quantity of uranium salts obtained from the sixteen tons of ore being practically fourteen tons, representing an assay value of about 90 per cent.

The whole of this production is practically obtained from two mines, both of which have been in operation for some centuries, being abandoned silver workings. The general geological formation of the district is mica schist inclosed in masses of granitic rock, and the ore mined is almost entirely pitchblende accompanied in some instances by limited quantities of other metalliferous ores such as silver, bismuth, and so forth. These latter, however, are merely recovered as by-products, the objective of the mining operations being uranium.

The plant installed for the treatment of the ores is very primitive though apparently fully adequate to the limited scope of the operations. The ore itself is found in lodes of varying widths—in some instances being only about an inch wide while in others over 10 feet in width. The pitchblende is for the most part recovered in large detached masses among the mica schist, and it is no uncommon circumstance to find such masses aggregating many pounds in weight. The percentage of pure uranium oxide, however, averages only about 3 to 4, and after hand picking undergoes but little further treatment, only being ground in a ball mill and the resultant product, assaying some 60 per cent of uranoso-uranic oxide, being then packed for transit to market.

The poorer ores are passed through crushers and wooden stamps for sliming. Here again the facilities are very crude but are sufficient to enable sliming to be carried out to secure an assay of about 55 per cent uranoso-uranic oxide. It would seem that the present would be opportune for the utilization of a more modern concentrating plant, but the experiments that have been carried out in this direction have not been sufficiently encouraging to warrant the displacement of the existing plant. The whole of the product is the property of the Austrian government, which purchases the ore by agreement. So jealously is the raw material regarded, that export of the ore is absolutely forbidden to other countries, though small parcels have been available to the laboratories of various countries for research purposes. Beyond this small quantity, however, no ore has been permitted to leave the country, the government itself undertaking the work of manufacturing the uranium salts of commerce. Bearing in mind that the industry is practically unknown beyond Austria, Germany being an insignificant rival, it will be seen that the price of the radium subsequently obtained is in a great measure under the control of the government monopolists.

For the purposes of carrying out the manufacturing operations a special uranium factory has been fitted up near the mines where the whole of this work is carried out. Close by is another important institution which has recently been inaugurated. This is a laboratory for the production of radium and research work in connection therewith, which is also state property. Owing to the limited demand for uranium, as may be supposed its market is very restricted so far as the substance in its pure state is concerned, but in the form of oxides of uranium, uranium acetate, uranium nitrate, sodium uranate, and so forth, it is of commercial value in the china and porcelain, photographic, and chemical industries. Only the manufacture of the uranium salts, however, is carried out here, this commodity being sold to those engaged in the production of the above compound forms, the average price varying between 50 and 60 cents per ounce. The demand in these circles though small has been fairly steady every year for some time past, but the increasing request for radium has imparted activity to the industry and stiffened the market, the Austrian government supplementing pitchblende supplies obtained in its native area, by the purchase of bulk consignments of Cornish pitchblende. For the extraction of the rarer metal about 10 tons of raw material is required to produce a few milligrammes of radium.

Recent developments have awakened interest in the Cornish deposits of pitchblende, since it is comparatively prolific in this tin-bearing county of Britain. Indeed it has been ascertained that the dumps of refuse extracted from the tin mines and which have hitherto been somewhat of a nuisance and an eyesore, and which anyone could have merely by carting away, have a high assay. During 1906, the manufacture of the uranium salts from this refuse, and carried out upon a small scale, resulted in a yield of eleven tons of uranium oxide. Huge dumps of pitchblende are scattered around one or two of the mines, aggregating several thousands of tons, but lack of enterprise has prevented their proper development, though some fifteen years ago 100 tons were conveyed to London for the purpose of ascertaining the assay value, which was found to be high, but nothing came of the experiments. Since the discovery of radium, however, large quantities have been shipped to the Continent and concentrated in various laboratories.

A substantial private syndicate has recently been formed for the erection of suitable works in Cornwall for the extraction of the radium. Owing to the large supplies of pitchblende immediately available around the shaft of the mine, which has been found to contain practically inexhaustible quantities of the raw ore, concentration expenses will be substantially reduced, and the competition thus established with the Austrian state monopoly will result in a substantial reduction in the cost of the rare metal. At the present time it has no marketable value. It costs at present about $100 a milligramme, which is equivalent to some $100,000 per gramme, but such a figure is purely artificial, since it is not produced on a commercial scale. The increasing demand for the mineral, however, necessitates its production being undertaken upon an extensive basis; and as operations are to be commenced at once in Cornwall, the metal will soon take its place among the commercial minerals of the world.

In scanning the list of automobile casualties it will be found that 90 per cent occur because the car is operated at too high a speed. The results are far-reaching, affecting not only the lives of the occupants, but incidentally awakening in the minds of the buying public a fear and general antipathy against the automobile. The wear and tear on the car increases by leaps and bounds after passing the normal speed of the machine. It is safe to say that the average car can be driven with less wear and tear 500 miles at a speed of say 25 miles an hour than 25 miles at 45 miles an hour. All automobile makers are crying down the speed craze. By the use of the speedometer the rate of travel can be made mathematically exact.

THE DYNAMICS OF LIFE.

THE ACHIEVEMENTS OF THE SCIENTIFIC FRANKENSTEIN.

BY A. DRZEWINA.

The most profound thinkers of all times have endeavored to lift the veil which enshrouds the secret of living matter. The medieval alchemist mixed substances of all sorts, in mingled hope and fear that a "homunculus" might spring from his crucible, and to this day we have continued to attempt the creation of

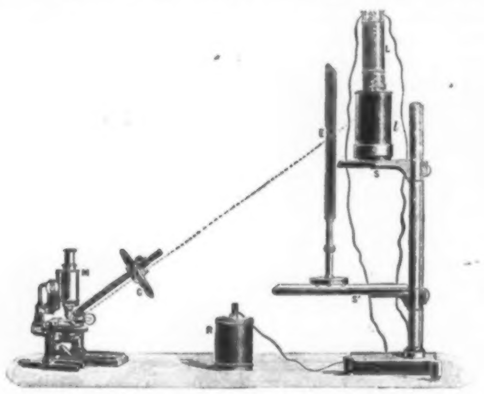


Fig. 1.—ARRANGEMENT OF THE ULTRAMICROSCOPE.

M, microscope; C, condenser; E, screen; L l, electric lamp; R, rheostat.

living matter, capable of spontaneous movement, growth, and reproduction. Are such attempts realizable? Prof. Jacques Loeb, in his remarkable new book, "The Dynamics of the Phenomena of Life," says:

"Living creatures are chemical machines which possess the property of growing, nourishing, and reproducing themselves automatically. No machine yet created by man possesses this fundamental property. This constitutes, at the present time, an essential difference between the living machines and all our artificial machines. But nothing forbids the supposition that experimental science may succeed, some day, in producing living machines artificially."

Thus the dream of Loeb is more audacious than any

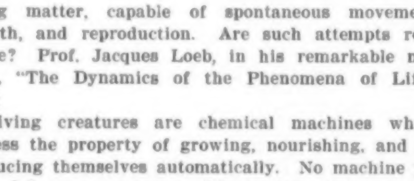


Fig. 2.—STRUCTURE OF A CELL.

that has been cherished by the boldest of his contemporaries, for it includes the production of "living machines," or living beings, as well as living matter. Fascinating though the task may be, it appears doubtful that we shall ever be able to produce true and complete protoplasmic bodies. Protoplasm, as we know it, bears the impression of all the influences, all the external causes which have acted upon it through countless centuries and have elaborated and altered it in every possible way. Is it not unreasonable to hope to produce, in a laboratory experiment, the final result of the exceedingly long process of natural evolution?

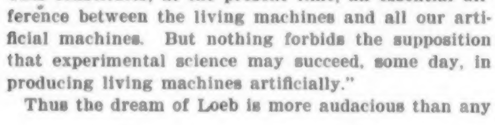


Fig. 3.—STAGES OF DEVELOPMENT OF OVUM.

Still, in view of the recent discoveries which have revolutionized science, we are tempted to admit that the production of living machines may be possible. Do not Ramsay's achievements in the transmutation of chemical elements prove the weakness of our conceptions and the timidity of our forecasts? It may be objected that all this concerns the distant future and that, for the present, it would be unwise to waste our efforts on such a problem. To this Loeb replies: "The moment to attack a problem comes with the appearance of a man who has the courage to attempt its solution and the intelligence and knowledge (perhaps, also, the good fortune) requisite for success."

We are still, however, very far from the artificial creation of living matter. But, in consequence of recent progress in biological chemistry, we are beginning to learn the composition of living matter and to understand and even to control certain vital phenomena which were formerly regarded as the deepest of mysteries.

It is now admitted that living matter is composed almost entirely of colloidal substances. Though the study of these substances is yet in its infancy their essential properties have been pretty clearly established.

Salt or sugar mixed with water disappears entirely, becomes a part of the liquid and cannot be detected by any optical means. Soap, gelatine, and albumen appear to dissolve in water in the same way.

Solid particles cannot be seen in the solution with the most powerful microscope, but they can be detected with the ultramicroscope, an apparatus which reveals the presence of objects whose dimensions are measured by millionths of a millimeter and are no greater than those attributed to the largest molecules.

The ultramicroscope (Fig. 1) is simply an ordinary microscope of high power with lateral illumination.

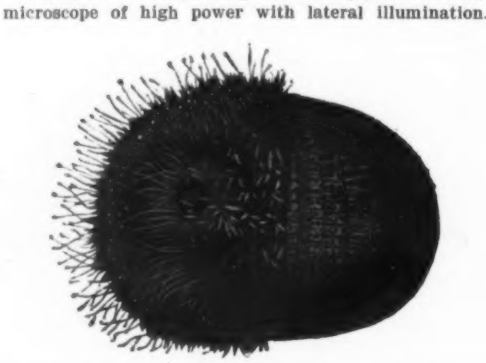


Fig. 4.—SEA URCHIN WITH HALF ITS SPINES REMOVED.

It is based on the principle that any object, no matter how small, can be seen on a black background if strongly illuminated. If the preparation, mounted between a glass slide and cover, is illuminated obliquely from beneath, the light, in general, will be totally reflected downward, but that part of the light which strikes small solid particles suspended in the medium will be diffracted in all directions, and a portion of it will enter the microscope. Hence the particles will appear like small stars in a black sky. Their forms and details cannot be studied. All that can be detected is their presence.

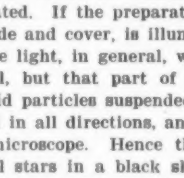


Fig. 5.—STARFISH.

When water containing gelatine or albumen in apparent solution is examined with the ultramicroscope, it is found that these substances are not dissolved, but are merely suspended in the water in the form of exceedingly fine particles, which are called granules.

The term colloids is due to Graham, who divided apparently soluble substances in crystalloids, which diffuse readily through animal membranes, and colloids, which diffuse slowly or not at all. Organic substances, such as albumen and gelatine, are not the only colloids. Gold, platinum, and other metals form colloidal solutions, which have recently been employed with success in therapeutics.

The granules of a colloidal solution bear electric charges, all of the same sign, and consequently repel each other and maintain the state of suspension. But they are also subject to mutual molecular attractions which cause them, in certain conditions, to coalesce, coagulate, and precipitate.

It is now admitted that most manifestations of life result from changes of state of colloids. The very complex structures which we distinguish in living substance are produced by the precipitation of colloids. The phenomena of cell division, motility and contractility of protoplasm result from alternate coagulations and liquefactions.

The precipitation of all the colloids means death. Thus a temperature of 113 deg. F., which coagulates albumen, quickly kills living cells, and the heavy

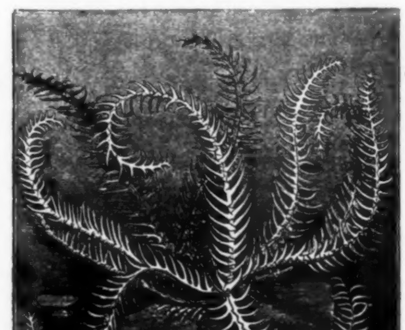


Fig. 6.—FEATHER-STAR (COMATULA).

metals, which precipitate albuminoids, are violent poisons.

Experimental parthenogenesis affords the most striking illustration of the fact that science is beginning to understand the essential phenomena of life, and it also shows the fertility of the modern theory of colloids.

The development of all but the lowest animals begins with the union of an ovum, produced by a female, with a spermatozoon, produced by a male. This union gives rise to an embryo which begins to develop as shown in Fig. 3. In general the ovum must be fertilized by a spermatozoon of the same species, but there are exceptions to this rule. Thus the horse and the ass, the wolf and the dog, the dog and the fox, and various species of birds and of fishes, can be made to breed together and produce hybrids.

Recent researches have thrown a new light on this

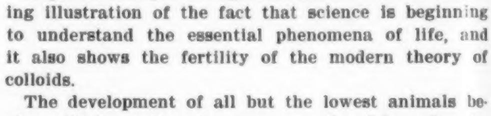
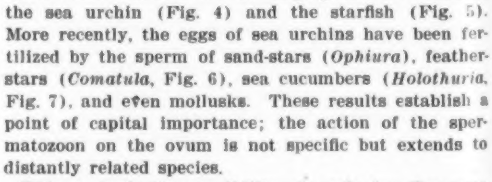


Fig. 7.—SEA CUCUMBER (HOLOTHURIA).

interesting subject of hybrids. It was formerly believed, and it is still believed by all who have not followed the latest advances of science, that hybridization is possible only between species of the same Linnean genus. Hence great surprise was manifested when Loeb succeeded in crossing species so unlike as the sea urchin (Fig. 4) and the starfish (Fig. 5). More recently, the eggs of sea urchins have been fertilized by the sperm of sand-stars (*Ophiura*), feather-stars (*Comatula*, Fig. 6), sea cucumbers (*Holothuria*, Fig. 7), and even mollusks. These results establish a point of capital importance; the action of the spermatozoon on the ovum is not specific but extends to distantly related species.

This suggests the possibility of producing the same effect by physical and chemical processes. An ovum is doomed to certain death if it remains unfertilized;



Before fertilization. After fertilization. Commencement of segmentation.

Fig. 8.—SEA URCHIN EGGS (AFTER HERTWIG.)

the act of fertilization preserves its life. But this act consists essentially in the addition of certain chemical substances which the ovum requires for its development. Experimental parthenogenesis consists in supplying these substances and thus compelling the ovum to develop without the assistance of male sexual products.

There is a natural parthenogenesis. The queen bee, for example, lays eggs of two sorts: fertilized eggs which produce workers and non-fertilized eggs which

produce males, the drones. Female aphides reproduce parthenogenetically for several generations, all the offspring being female, until autumn. Then males appear and the females lay fertilized eggs which hatch in the following spring and produce females only. But such cases are rare.

Now, the fertilizing effect of the spermatozoon can be reproduced in every detail by physical and chemical means. The remarkable results thus obtained are due chiefly to Loeb.

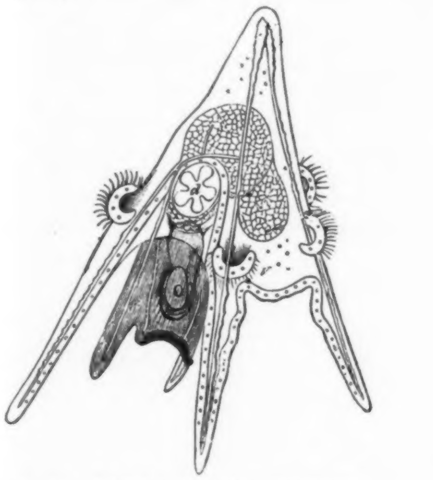


FIG. 9.—LARVA OF SEA URCHIN.

In France, Delage has conducted similar researches with great zeal and success.

In the simplest of Loeb's methods, unfertilized eggs of starfish or sea urchins are placed in hypertonic sea water, that is to say, sea water to which chloride of sodium, potassium, or magnesium has been added. After a few hours' immersion the eggs are replaced in ordinary sea water. Segmentation, or cell division, soon begins, and in a day or two actively swimming larvæ (Fig. 9) appear.

The development thus effected differs from the natural development in several respects. An ovum which has been penetrated by a spermatozoon soon becomes invested with a characteristic membrane, called the vitelline membrane. No such membrane appears on eggs fertilized by hypertonic sea water. Furthermore, the artificially fertilized eggs develop very slowly, not more than one-fifth of them produce living larvæ, and the larvæ remain at the bottom of the vessel, while natural larvæ swim at the surface.

Loeb subsequently devised the following method, in which all the details of natural fertilization are imitated.

The eggs are first placed in sea water mixed with butyric, valerianic, caproic, or some other fatty acid. After the immersion of a minute or two they are put back into ordinary sea water. All the eggs now form membranes like those of naturally fertilized eggs. Five or six minutes after the formation of the membranes the eggs are immersed in hypertonic sea water for from 20 to 45 minutes. In these conditions nearly all the eggs undergo segmentation and produce larvæ which swim at the surface of the water.

Delage employs a different method, based on the theory that an ovum, or a cell in general, is a complex of colloidal substances more or less intimately mixed, of which some are coagulated and some are in colloidal solution. The phenomena of the development of the fertilized ovum, and of cell multiplication in general, consists of a series of coagulations and liquefactions.

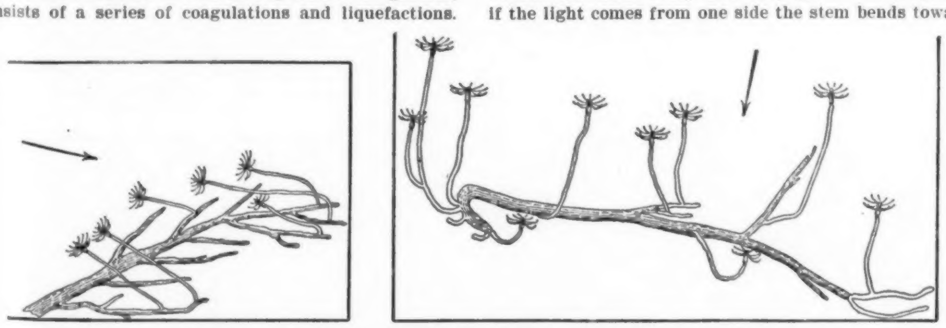


FIG. 10.—POSITIVE HELIOTROPISM OF EUDENDRIUM.

The arrows indicate the direction of the rays of light. (Drawn from Loeb.)

The formation of the vitelline membrane is a coagulation, its disappearance is a liquefaction; the formation of radiating lines, spindles, chromosomes, etc., is a coagulation, yet subdivision of chromozomes and the vanishing of rays and spindles are liquefactions. Now, certain substances, added to a colloidal solution, cause coagulation, while other substances prevent it, or cause liquefaction. Hence Delage inferred the possibility of forcing an unfertilized ovum to develop normally by treating it with suitable coagulants and liquefiers at the proper times.

As a rule, acids coagulate and alkalies liquefy protoplasm. By treating unfertilized eggs with tannic acid and ammonia Delage has obtained perfectly normal larvæ and even adult forms of sea urchins and starfish.

There are many more or less successful methods of experimental parthenogenesis. Dehydration appears to

FIG. 11.—TUBE WORM. (SPIROGRAPHIS.)

be an essential factor, and this can be brought about by various agencies—hypertonic solutions, alcohol, elevation or lowering of temperature, etc. Giard exposed sea urchins' eggs to the air on filter paper, and found that some of them began to develop. In some cases segmentation can be started by shaking unfertilized eggs. Loeb has recently succeeded in fertilizing sea urchins' eggs with the blood of the spoon-worm (*Sipunculus*). This proves that the substances required for the development of the ovum are not contained exclusively in the spermatozoon, but exist also

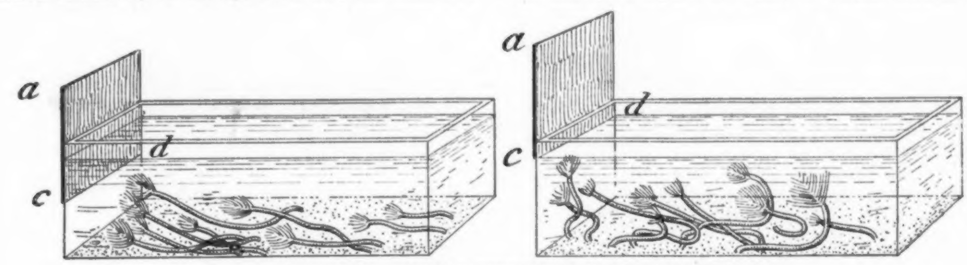


FIG. 12.—POSITIVE HELIOTROPISM OF TUBE WORMS.

The light enters from the left under the metal plate *a c d*. (Drawn after Loeb.)

in other animal cells and fluids. The spermatozoon, however, contains them in the most effective proportions and serves to convey them to the ovum.

Let us now examine another vital phenomenon—motion. Spontaneous movement is the most characteristic property of living creatures, yet we shall show that the movements of lower animals are spontaneous only in appearance, that they are governed by laws, the knowledge of which would enable us to predict the character of the movement in any given case.

Plants grow toward the light. If they are equally illuminated from every side they grow vertically, but if the light comes from one side the stem bends toward that side. This tendency to seek the light is called heliotropism. Now Loeb has proved that heliotropism exists in animals as well as in plants.

In the case of fixed animals the demonstration is easy. If a hydroid, *Eudendrium*, growing in an aquarium, is illuminated from one side, its branches curve toward the light until the rays strike symmetrical points of the polyps at equal angles (Fig. 10).

A tube-worm, *Spirographis* (Fig. 11) lives in a tube attached by one end to a fixed support. From the free end protrudes the ring of tentacles that surrounds the mouth of the animal. Under lateral illumination the free end of the tube turns until it becomes parallel to the luminous rays (Fig. 12).

The same influence which causes plants and fixed animals to turn, leads locomotive animals to swim, crawl, or fly, toward the light. Infusoria, planaria, rotifera, worms, mollusks, crustacea, and insects do not seek the light because they "love" it but because they cannot do otherwise.

Animals are called positively or negatively heliotropic according as they turn (or move) toward or away from the light. Animals of both classes assume positions in which symmetrical points of the body are equally illuminated. Following this instinct a crab

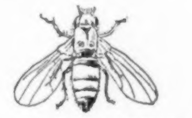


FIG. 13.—DROSOPHILA.

or an insect blind in one eye will travel around a light, in a circle, for hours.

Several other external agencies have similar effects and so, besides heliotropism, we have geotropism, galvanotropism, stereotropism, chemotropism, etc. In all cases the animal assumes a position in which the symmetrical points of the body receive, so to speak, equal numbers of *lines of force* per unit of surface. According to Loeb, this action is due to the fact that the symmetrical points of the body have the same morphological structure and chemical constitution. If one part of the body receives more lines of force than the symmetrical part on the opposite side, the muscular contractions, and consequently the motions of the two sides, become unequal. The result is a rotation which brings the animal into the position of symmetrical stimulation.

A little fly, *Drosophila*, feeds by preference on fermenting fruit, toward which it flies in a straight line, both in daylight and in darkness. It is attracted in the same way by ethyl and amyl alcohols, ether, lactic and acetic acids, and other compounds found in fermenting fruit. When a *Drosophila* is deprived of one of its antennæ (the organs of smell) it circles around the fruit or alcohol instead of approaching it directly.

According to Loeb, the effects of light and some other agents upon the organism are chemical effects. If this is true it should be possible to modify heliotropic reactions by chemical means. This result has been accomplished. A fresh-water crab (*Gammarus*) which, naturally, is negatively heliotropic, becomes positively heliotropic when a trace of acid is added to the water. The same change is produced in the larvæ of a marine annelid (*Polygordius*) by adding fresh water.

The sign of a tropism can be reversed by a variety of agents—alcohols, acids, alkalies, elevation or lowering of temperature, concentration or dilution of the medium, etc.

Bohn has called attention to the fact that these are the agents that provide artificial parthenogenesis. Hence these two vital phenomena, apparently so unlike, are determined by the same physical and chemical conditions.

Let us suppose that the transformation of lifeless into living matter has been accomplished. The next problem would be to transform one species into another. A few years ago this appeared impossible, or possible only by slow changes extending through thousands of centuries, in accordance with the Darwinian theory of evolution.

But that which appeared impossible yesterday has become possible to-day. Not only have we learned, from the researches of de Vries, that new species may appear spontaneously, but we know also that we can, by certain methods of treatment, evolve a new species from an old one. Blaringhem has produced new varieties, and even a new species, of maize by means of artificial mutilations. The results are yet meager, for we do not know the relation between cause and effect, and success is a matter of chance. But the work is only beginning and, though new species are sometimes produced by sudden mutations, human discoveries usually require long incubation and slow, progressive development.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from La Science au XXme Siècle.

THE WARFARE OF THE FUTURE.*

THE PROBABLE DEVELOPMENT OF THE EXPLOSIVE AND THE PROJECTILE.

BY HUDSON MAXIM.

How will the battles of the future be fought? In our reasoning we are obliged to proceed from the simple to the complex, from what we know to what we would learn. In order to forecast the future, it is necessary to recast the past.

We are to-day marching in the van of achievement with a vast wealth of accomplishment behind us. Still, relatively speaking, we are merely entering at the very threshold of invention.

When primitive man first learned that with a club as a weapon he could vastly reinforce his teeth and fists and claws, he doubtless thought that there remained but little chance for further improvement in weapons of warfare.

The human hand has been forged from the fin of a fish by the human brain. The hand, in its turn, has built upon the microscopic terminal ganglion of the primitive cordworm the giant brain of a Herbert Spencer, infinitesimal piece by piece. Hand and brain have always worked together in a close partnership.

When we compare the course of human invention with the evolutionary processes of nature, we are struck by the parallelism. Everywhere in nature there is a fierce rivalry that stimulates to improved variation to meet the exigencies of necessity. The complex is evolved from the simple and the large has small beginnings. The intelligently selective grows out of blind inertia tending always toward the survival of the fittest. Had we infinite powers of understanding of the natural processes, we should then have infinite foresight too and should be able to forecast with unerring accuracy what the future has in store. A sufficient knowledge and observation of nature would have foretold each before its invention, by some parallelism or counterpart in nature, many of the greatest inventions of man.

The screw propeller would have been foreseen in the tail of the fish. The armored saurian of the reptilian age would have given a foreview of the armored knight of the middle ages, destined to hold the mastery awhile, and doomed in turn, just as the old hard-hided antediluvian monsters went down before the agile sharp-toothed carnivora, to fall beneath the supremacy of the light-footed unhelmeted soldier, without shield or cuirass, but whose powers of offense with firearms become too his best means of defense.

The old flint-lock blunderbuss charged with lead and black gunpowder was thought pretty near perfection as a weapon of war. Still, the coat of mail was laid aside slowly and reluctantly; also slowly and reluctantly with the further improvement in firearms did armies break from solid rank formation and disperse over large areas and fight in skirmishing order.

To-day it has become a recognized truism of military science that victory depends upon the concentration of attack upon the most vital points of an enemy's position, while offering to the enemy the minimum of vital exposure. To this end, wisdom has led to the division and dispersion of the men and enginery constituting the units of attack, while still enabling each attacking unit to concentrate upon any desired point of the enemy's position.

The greatest means of defense are efficient means of offense. The greatest protection against receiving heavy blows is to be able to strike heavy blows. A heavy blow upon an enemy is far better than heavy armor on one's self.

Naval warfare too must soon conform to the wisdom of this lesson, and the battleship, the gigantic armored saurian of the sea, is destined to be dominated in the near future by some agile, swift, sharp-toothed carnivora of destruction.

In ancient times, when men fought with clubs and swords and spears, victory depended upon the actual amount of brute force that could be opposed to brute force, and little depended upon science. With improvements in weapons, warfare becomes more and more a matter of exact science and the military man becomes more and more a civil and mechanical engineer. In the military land operations of the future, science will more than ever be supreme above mere brute force.

Nothing is more apparent than a simple proposition after it has been well learned. To hitch up a steam engine to propeller wheels and drive a boat looks simple enough to us all now, but when Fulton proposed a steamboat voyage up the Hudson, the undertaking appeared about as incredible to most people of the time as a suggested voyage to Mars would now be.

The old wooden hulk was in its day a dare-devil innovation. He was a revolutionist, in the inventive sense, who first fired heavy guns from a ship's deck. The present battleship is only a highly developed "Monitor," just as the old wooden sailing ship was a highly developed trireme.

It is the same conservative spirit to-day that believes in the battleship as the final arbiter of national supremacy that once believed in the old wooden-sides and adhered to them, opposing all innovations; the same spirit of conservatism that adhered to the Roman galley and placed its faith in the crew of the galley slaves rather than upon the uncertain wind; the same conservatism that made the Carthaginians adhere to their outclassed triremes; and, in inverse order, it is the same spirit of invention combating entrenched conservatism that led the Romans to build their galleys for close-order work, armed with grappling hooks, with which they secured their vessels to the Carthaginian triremes, where the Roman short sword could be brought into play.

When, in the first Punic war, the primitive Roman fleet met and was vanquished by the Carthaginians, the order of battle was the same as it is to-day. The vessels lined up at such a distance apart as would enable the Carthaginians to strike the Romans with their long-range arrows and the stones hurled by their Balearic slingers. When, however, the Romans devised a means whereby they were able to run them down and grapple with them in hand-to-hand conflict, victory was with the Romans.

The next great improvement in naval warfare will be on the lines of ways and means of repeating what the Romans did—ways and means of charging upon and grappling with the mighty war vessels of an enemy, to sink them with the short sword of high explosives.

There is no one thing so much needed in naval warfare at the present time as a more efficient means of reaching battleships and cruisers with a sufficient quantity of high explosives for their destruction; in other words, there is a more imperative demand for improvements in torpedoes and torpedo boats than in any other branch of the naval service.

The effective range of the modern high-power gun is now about five miles, and it is the range of the guns that determines the distance between the lines of battle of modern fleets; and the fleet with guns of the longest range has the opposing fleet at its mercy.

A little while ago the Whitehead automobile torpedo was thought to be a valuable adjunct to the armament of the modern battleship, but the range of the guns has now been so increased that such torpedoes become a useless incumbrance, because of the shortness of their range, notwithstanding the fact that their manufacturers have done everything possible to perfect them and to increase their speed and range. Their range is necessarily limited to that attainable by the charge of compressed air they are capable of carrying.

During the past few years the air pressure has been increased from 1,300 pounds to the square inch to 2,250 pounds to the square inch, and the weight of air from sixty pounds to one hundred and thirty pounds in the eighteen-inch torpedo; and still the maximum range of the eighteen-inch torpedo is only from 3,000 to 3,500 yards, practically about one-third of the range of the high-power guns which determine the distance apart of the lines of battle; and the maximum rate of speed of this torpedo is about thirty-five knots.

In order to carry the air under the enormous pressure, a very strong and very heavy steel air flask is needed; and as the weight of the entire torpedo must not exceed the weight of the water displaced by it, the propelling mechanism has necessarily to be made very light and delicate for the energy it has to transmit.

But what is far more important, the explosive charge also has to be reduced to a minimum, in order to float the heavy air-flask and the weight of air it contains; and this notwithstanding the fact that the quantity of high explosive ought to be greatly increased in order to insure destruction of the warship struck by it. In the recent war between Russia and Japan the Whitehead torpedo proved a great disappointment.

If the speed of an automobile torpedo could be increased fifty per cent, its accuracy also would be greatly increased, for it would be far less affected by currents, and would be far more likely to strike a moving target, while if its range could be increased one hundred per cent, it would then become an efficient adjunct to the armament of every war vessel, whereas if its range could be increased to five miles—practically three times what its range now is—even though its speed were to remain at thirty-five knots, it would be able to pass over the intervening space separating the lines of battle of opposing fleets.

During the last ten years I have conducted a large number of experiments at a cost of more than $50,000 in the development and demonstration of a system for the propulsion of automobile torpedoes and torpedo boats by energy derived from the products of combustion of a self-combustive fuel called motorite, consisting of seventy per cent nitroglycerine and thirty per cent gun-cotton. The gun-cotton is gelatinated by the nitroglycerine, forming a dense, tough, and rubbery material. This material is made into bars about seven inches in diameter and six feet long, for use in torpedoes the size of the eighteen-inch Whitehead torpedo. For the twenty-one-inch torpedo the stick will be both bigger and longer.

The motorite bars are forced into and sealed in steel tubes for use, and these steel tubes containing the motorite are inserted into the torpedo and are surrounded by a water-jacket. The motorite can be ignited and can burn only at and from one end, and water is forced through the water-jacket into the combustion chamber, to be evaporated by the flame blast forcing the water along with it through an atomizing device, whereby it is instantly converted into steam, and the combined steam and products of combustion form the motive fluid.

The water will be taken in from the sea as required, so that it will not be necessary to carry the water supply on board the torpedo.

One pound of motorite evaporates a little over two pounds of water, so that one pound of motorite produces the equivalent of three pounds of steam, for the products of combustion of the motorite mingle with the steam produced. The steam from the combustion chamber is conducted to turbines, or other engines or devices for propelling the torpedo through the water. By means of this system of propulsion, the range of the automobile torpedo can easily be doubled, while at the same time its speed can be increased fifty per cent. The heavy air-flask will be done away with and will be replaced by a shell merely strong enough and heavy enough for structural rigidity.

This will enable the carrying of one hundred and sixty pounds of motorite in place of the one hundred and thirty pounds of air now carried; and as each pound of motorite will evaporate two pounds of water, we have available four hundred and eighty pounds of motive fluid; and as steam and products of combustion of motorite are much more efficient as a motive fluid per unit of weight than compressed air, it is safe to assume that we have available four times the energy now available in the eighteen-inch torpedo.

Instead of carrying but two hundred pounds of wet gun-cotton—the present charge—we should be able to carry three hundred pounds of maximite, which is practically twice as powerful per unit of weight as gun-cotton, while its density is fifty per cent greater than that of gun-cotton, so that we should have a warhead easily three times as powerful as the present warhead.

The thing most needed at the present time is a torpedo-boat capable of passing unscathed through the fire of quick-firing guns of a battleship in order to get near enough to reach her with certainty with torpedoes carrying a sufficient quantity of high explosives in the warhead to insure her destruction when hit.

It is a recognized truism in the field of invention that when there is a very strong demand for anything against which there is no physical law barring its accomplishment, it is sooner or later sure to be accomplished.

There is an enormous demand for a system for reaching and torpedoing battleships with destructive quantities of high explosives. I am strongly of the opinion that the most effectual way of accomplishing the result is to construct a torpedo-boat in the following manner:

Build the hull of the boat somewhat on the lines of the cigar-shaped automobile torpedo—even a perfect counterpart of the torpedo in shape would serve the purpose well; but I would suggest a little greater vertical than longitudinal diameter. In other words, I would build the boat a little more fish-shaped than

* Address before the New York Section of the American Chemical Society.

the torpedo, and I would construct it so that it would be adapted to travel both upon the surface of the water and in a semi-submerged position, or rather, in a nearly submerged position.

I would drive the boat with gasoline engines under normal conditions, and when going into action—that is to say, in making the run of attack—the boat would be in its nearly submerged position and would be driven by the combined power of the gasoline engines and motorite.

The gasoline engine will be provided with a shift gear, something like that employed on automobiles, so that under normal conditions, that is to say, when the boat is propelled along the surface of the water by the gasoline engines alone, the propellers will be driven at a slower speed, and a speed adapted to the speed of the boat thereby secured; but when going into action in a submerged position and traveling at possibly double the speed, the gear will be shifted so that the propellers will travel at a speed commensurate with the higher speed of the torpedo-boat.

The boat will be provided with a top keel or fin a little thicker than a man's body across the shoulders at the rearward end, being narrowed down forward, and a conning-tower large enough for a man to stand in erect.

The front end of the superstructure will be sharp, and water will be thrown to right and left and will not obscure the forward view of the occupant of the conning-tower. The superstructure will be subdivided into small compartments, filled with cellulose. The partitions between the compartments will be thin sheet metal.

The whole superstructure, except the conning-tower, will be very light and entirely dispensable, and can be shot away without actual damage to the boat itself. The superstructure will be for flotation purposes only, serving to tie the boat to the surface of the water, while the boat itself will be actually submarine. The superstructure will project above the surface of the water about a foot.

The conning-tower will be protected by thin armor plate thick enough to resist the projectiles of small quick-firing guns, and there will be no danger of being hit by guns of a larger caliber.

It will be extremely difficult to hit either the superstructure or the conning-tower, even with small quick-firing guns, for the conning-tower will not be more than two feet above the surface of the water, and will not exceed three feet in diameter, and will be moving forward at the rate of from forty to sixty miles an hour.

Of course, it will require stupendous energy to propel a submarine boat through the water at so high a rate of speed, and there is nothing available known to me except motorite which can supply the required energy. With motorite, however, we have easily all the energy that may be required for any desired rate of speed until the motorite be entirely consumed.

Enough motorite can easily be carried to drive such a submarine boat at a speed of sixty miles an hour for a distance of thirty miles. This will be sufficient to overtake and sink any battleship that might be sighted. Of course, a speed of forty-five miles an hour can be maintained for a much longer time, probably for an hour and a half, with the same quantity of motorite.

The Whitehead torpedo is in reality a sort of submarine torpedo-boat, and what is true of it also holds true of the torpedo-boat I propose. Of course, the keel and superstructure in the boat I propose would offer additional resistance, but, on account of the larger size of the boat and its greater length and the enormous quantity of motorite that may be carried, we shall have available more than enough energy to make up for the increased resistance.

The boat will carry, say, a couple of torpedoes in the prow and launch them when getting within close range of a warship. These torpedoes should each carry at least five hundred pounds of high explosive. It would be better if they carried half a ton each in the warhead.

The cost of the torpedo-boat will be slight compared with the destruction it can work. Besides, there need be only two men on board and the lives of but two men will be endangered anyway, and notwithstanding the danger to the men making such an attack, even though the chance of being killed were to be one in two, or even more, there will be no lack of volunteers.

A portion of what I have just said about my system of propulsion of torpedoes and torpedo-boats appeared in the September number of the Metropolitan Magazine; but I have several inventions relating to the construction of torpedo-boats that have never yet been published, and one of these is a method for taking on and discharging water with very great rapidity for the submergence and emergence of a semi-submarine torpedo-boat of the type already described, whereby these evolutions could be performed with nearly the facility with which a duck can dive.

Another invention is a torpedo-boat warhead, carried by or forming a part of the bow of the torpedo-boat itself instead of forming a part of an automobile torpedo to be launched by the torpedo-boat.

I have shown how a torpedo-boat may be made so that it may safely run through the zone of fire of a battleship to launch its torpedoes at close range. I am, however, of the opinion that a far better way, and one which will be adopted in the near future, will be to employ a torpedo-boat which shall itself constitute an enormous torpedo. It will be a species of ram; but instead of depending upon the steel prow for punching a hole in a warship, it will be armed with a ton of high explosive. How about the crew? No, it will not be necessary to sacrifice the crew. The boat will be made, say three hundred feet in lengtn over all, and a hundred feet of the prow portion of the boat will be wholly dispensable and may be blown away without injury to the boat proper, the boat proper being but two hundred feet long.

The warhead of the torpedo-boat will strike the battleship below its armor belt and the blast of the explosion will be inward and upward through the warship, while the reacting blast of the explosive charge will not be very severe upon the occupants of the torpedo-boat. They will be hurled back by an enormous wave of water, but it will not be a quick, sharp destructive blow, dangerous to the occupants of the boat or to the boat itself.

After torpedoing a warship, the torpedo-boat, with its dispensable bow blown off, will still be in perfect trim to retreat and escape. The crew of the battleship at this juncture will be busy with their prayers.

Of course, this torpedo-boat will not supplant the automobile torpedo, for that will be employed in other evolutions; but for the direct run in upon a warship, this form of torpedo-boat with a ton of high explosive in the warhead will be the main arm of naval service, for nothing under heaven could prevent one of these torpedo-boats from selecting any battleship in any fleet and sinking it without a chance in a hundred of being prevented.

(To be continued.)

INTERNATIONAL ATOMIC WEIGHTS FOR 1909.

THE International Committee on Atomic Weights for 1909, composed of F. W. Clarke, W. Ostwald, T. E. Thorpe, and G. Urbain, has adopted the following values:

Ag—Silver	107,88	N—Nitrogen	14,01
Al—Aluminium	27,1	Na—Sodium	23,00
Ar—Argon	39,9	Nb—Niobium	93,5
As—Arsenic	75,0	Nd—Neodymium	144,3
Au—Gold	197,2	Ne—Neon	20
B—Boron	11,0	Ni—Nickel	58,68
Ba—Barium	137,37	O—Oxygen	16,00
Be—Beryllium	9,1	Os—Osmium	190,9
Bi—Bismuth	208,0	P—Phosphorus	31,0
Br—Bromine	79,92	Pb—Lead	207,10
C—Carbon	12,00	Pd—Palladium	106,7
Ca—Calcium	40,09	Pr—Praseodymium	140,6
Cd—Cadmium	112,40	Pt—Platinum	195,0
Ce—Cerium	140,25	Ra—Radium	226,4
Cl—Chlorine	35,46	Rb—Rubidium	85,45
Co—Cobalt	58,97	Rh—Rhodium	102,9
Cr—Chromium	52,1	Ru—Ruthenium	101,7
Cs—Caesium	132,81	S—Sulphur	32,07
Cu—Copper	63,57	Sb—Antimony	120,2
Dy—Dysprosium	162,5	Sc—Scandium	44,1
Er—Erbium	167,4	Se—Selenium	79,2
Eu—Europium	152,0	Si—Silicon	28,3
F—Fluorine	19,0	Sm—Samarium	150,4
Fe—Iron	55,85	Sn—Tin	119,0
Ga—Gallium	69,9	Sr—Strontium	87,62
Gd—Gadolinium	157,3	Ta—Tantalum	181,0
Ge—Germanium	72,5	Tb—Terbium	159,2
H—Hydrogen	1,008	Te—Tellurium	127,5
He—Helium	4,0	Th—Thorium	232,42
Hg—Mercury	200,0	Ti—Titanium	48,1
In—Indium	114,8	Tu—Thulium	168,5
Ir—Iridium	193,1	U—Uranium	238,5
I—Iodine	126,92	V—Vanadium	51,2
K—Potassium	39,10	W—Tungsten	184,0
Kr—Krypton	81,8	X—Xenon	128
La—Lanthanum	139,0	Y—Yttrium	89,0
Li—Lithium	7,00	Yb—Ytterbium (Neoytterbium)	172
Lu—Lutetium	174	Zn—Zinc	65,37
Mg—Magnesium	24,32	Zr—Zirconium	90,6
Mn—Manganese	54,93		
Mo—Molybdenum	96,0		

WAXING CEMENT FLOORS FOR DANCING HALLS.

A METHOD of waxing a cement floor so that the room can be used for dancing purposes is thus described in a recent issue of The Painters' Magazine: Cement floors are as a rule too porous to be waxed successfully without being first filled. Though rather expensive, shellac varnish is most convenient and best adapted for preparing the floors in the shortest possible time. Two thin coats of orange or brown gum shellac dissolved in denatured alcohol will give the proper foundation for the wax, which should be ordinary floor wax applied with a cloth or brush and polished with a weighted floor brush in the usual manner.

MAKING WINDOW FRAMES.

THE making of window frames is part of the business of every planing mill catering to the building trade, and it is a part that is practically always done to special orders, says a writer in a recent issue of the Wood Worker. From time to time, efforts have been made to get this work more in hand, so that quantities of window frames can be made up during the dull season of the winter and have them on hand when the busy building season comes on, thus having something to do in the winter and have the stock ready to help out in the busy times. By making them up in large quantities they could be made up at less cost on machines. But it has been difficult to get much good out of this idea because of the wide diversity of requirements. Yet it looks like now the tide has turned in favor of the making up of stock sizes in advance.

In fact, this window frame business, like the column business, is being specialized more or less, and some people are going into it and furnishing window frames either made up or all cut out ready to be made up, just like people making a specialty of furnishing columns for the retail lumberman. Of course, it is impossible to carry all the great varieties of sizes and designs, but there is seemingly an effort on the part of retailers now to try and push certain stock sizes so that they can carry them in stock just like they carry the sash. This is a move that should be encouraged by planing mill people, because it gives the planing mills a chance to make something out of the window frame business, in building up trade among the different dealers in their territory, and to keep busy during the winter months and other slack periods by making up stock frames and having them ready. In addition to pushing this branch of the business, and making a feature of window frames, they can enlarge on the work considerably by having the stock already run through the sticker and having the equipment in such good shape generally that when an order comes for a special lot of windows for a house they can be furnished promptly. Some planing mills make such a feature of this quick action in furnishing frames made to order that they can take an order for frames for an ordinary dwelling, and turn them out and deliver them inside of 24 hours. It takes a little extra work and trouble in the way of being prepared to do work in this way, but it seems to be worth while because it helps get business.

The best chance of profit, however, in the window frame business comes from the standardizing of them as much as possible in sizes and kinds, and the making of them in larger quantities. This gives a chance to furnish them for less money and still make a better profit out of the business than if each set of frames is made separately to order. So it is worth while to study this end of the business and see how much it can be enlarged upon by diligent effort.

A recent development in Germany should offer great possibilities. This is the supply of gas in cylinders adapted for the lighting of country houses and rural districts. The gas has been invented by Hermann Blau, a chemist, and is distilled from oil and other materials. Manufacture is carried out upon new and novel lines. The oil is fed into the retort and distilled at a lower temperature than that employed in coal-gas manufacture. The by-products are secured, and the gas cleaned and scrubbed in the usual manner. It is then compressed at great pressure in cylinders similar to those employed for the transportation of oxygen, the effect of this pressure being a liquefaction of the gases. The permanent gases which distillation has yielded, such as hydrogen, methane, and carbon monoxide, the chief constituents of coal gas, are then dissolved to the required extent in the liquid gases. When the pressure is relieved the liquid volatilizes, carrying off a certain proportion of the gases which were dissolved. The light obtained is of great brilliancy, while the gas is perfectly pure and harmless. The cylinders are of varying lengths and capacity, it being possible to acquire a small vessel holding one pound of gas, suitable for traveling, boating, or camping-out expeditions, up to large reservoirs containing heavy supplies suitable for extensive country seats. The medium size, adapted for use in small villas, will supply enough gas to meet requirements for some eight weeks. All that it is necessary to do is to install the charged cylinder in the receptacle supplied for the purpose outside the building, connect it up to a small tank in which the pressure is regulated, and then admit it to the ordinary piping-system of the house. When a cylinder is empty it can be easily and quickly disconnected, and a full cylinder replaced, the empty one being returned to the works for a fresh charge. There is no possibility of explosion, and no technical knowledge is necessary for its manipulation. In Ger-

many several villages are being lighted upon this system. The distributing mains are laid in the usual manner, though small pipes need only be used, and are connected up to a small hut in which the gas cylinders are placed. The only attention required is the changing of the cylinders as they become exhausted. The system is cheap, highly efficient, and free from danger, and even the smallest villages can become possessed of a complete gas-distribution plant at a nominal outlay.

ENGINEERING NOTES.

In hydraulic mining in Victoria, Australia, gravel is being elevated to great heights. At the Creswick Black Lead the tailings are being raised to a height of 102 feet by a three-port runner pump in one lift, the depth of gravel worked being 70 feet. At the Cock's Pioneer mine, where an 80-foot bank of gravel is being worked, the tailings are being raised to a height of 123 feet in two lifts.

Alaska gives promise of becoming in time a large producer of copper. The Bonanza mine in Montana has an ore body 300 feet wide, which was cut at a depth of 235 feet by a cross-cut tunnel, in which there is 120 feet of ore averaging 22 per cent copper, the middle 24 feet being almost pure copper glance running from 60 to 70 per cent of copper and 28 ounces of silver per ton. This is probably one of the greatest showings of copper in North America, but the property is over 100 miles from railroad transportation, so that it will be several years before this copper can possibly come on the market.

The Lehigh Valley Railroad Company has recently introduced crude oil tire-heaters at their system shops at Sayre, Pa., which have been found far superior to the former method of using gasoline and perforated rings for the application and removal of tires. The heater for removing tires consists of six oil burners mounted on a frame adjustable to any desired diameter. The frame consists of an arrangement of wrought-iron pipe mounted on a pair of wheels. On the main part of the frame a combination air and oil chamber is arranged to slide forward and back, and in conjunction with a six-point star the various adjustments of the burners are produced. On the front side of the supply chamber six ball-joint connections are made to the oil supply, also six connections are made to connect the air supply with the burners and piping arranged to connect the burners with the supply chamber. When using gasoline for removing tires, two men would use from 20 to 50 minutes in removing a tire, while with this heater from 7 to 11 minutes are required. While the old tires are being removed new ones are piled up on three cast-iron blocks, and a large crude oil burner is placed underneath, the former having the capacity to fill the inside of eight tires with flame and heat them for application in twenty minutes. Inasmuch as both heaters are comparatively smokeless, there is perfect satisfaction. During a test six old tires were removed and six new tires were applied in one hour and fifty-two minutes.

The work of the metal-miner being limited to the extraction from the earth's crust of the ores of the various metals, while it is the business of the metallurgist to smelt these, so as to reduce therefrom the metals that they contain, and to fit the latter for their use in the arts, the question what constitutes an ore is one that the miner cannot answer for himself, and for the reply to which he is dependent entirely upon the development of metallurgical science for the time being. Not all metalliferous minerals are ores from the smelter's point of view. Take, for example, an ordinary brick clay, which is a complex hydrous silicate containing, say, 15 per cent of aluminium and 5 per cent of iron; it is true that we can extract both these metals from it by a series of complicated laboratory processes, but no means for doing this economically on a practical working scale have yet been discovered. Hence no one would dream of calling clay an ore of aluminium, and far less of iron. Nevertheless, it is not beyond the bounds of possibility that our modern metallurgists, or their younger and more progressive brethren, the electro-metallurgists, may within a few years devise some practicable process for extracting aluminium from clay, when clay would straightway become an ore of aluminium, though it is not one now; and if perchance it happened that comparatively pure oxide of iron were obtained as a by-product in the same process, the clay might even be reckoned as an ore of iron also. Until some such process shall be devised, clay is looked upon by the metal-miner as a non-metallic mineral, as so much worthless gangue or waste. The history of metal-mining has shown again and again that the waste rock of one generation is the valuable ore of another, as, for example, the zinc blende of the Alston district, which is now being recovered from the waste which the old miners had left behind as worthless in their excavations, or had thrown aside on their waste heaps, the value of the mineral having been recognized when a Belgian metallurgist discovered how to extract zinc from it.

SCIENCE NOTES.

Bulletin No. 136 of the Bureau of Plant Industry of the U. S. Department of Agriculture is devoted to an article, by Mr. O. F. Cook, on methods and causes of evolution. The doctrine of evolution is now being made of practical use in the solution of problems connected with breeding and acclimatization, and the paper is written to a great extent from this point of view. The author commits himself to the opinion that "evolution is not caused by the struggle for existence, nor limited to characters of environmental fitness. Harmless and even harmful characters may be acquired by species in the same way as beneficial adaptations." This is indorsed by Dr. A. G. Bell, who communicated the following comment quoted in the letter of transmittal: "I, too, entertain the feeling that natural selection does not, and cannot, produce new species or varieties, or cause modifications of living organisms to come into existence. On the contrary, its sole function is to prevent evolution. In its action it is destructive merely, not constructive—causing death and extinction, not life and progression. Death cannot produce life; and though natural selection may cause the death of the unfit, it cannot produce the fit—far less evolve the fittest. It may permit the fit to survive by not killing them off if they are already in existence; but it does not bring them into existence or cause improvement in them after they have once appeared. We must look to other agencies for the causes of evolution."

In a paper read before the British Association for the Advancement of Science, Sir Howard Grubb, F. R. S., pointed out that for certain purposes it was necessary to produce a divided object-glass telescope, in which the rays forming the images on one-half of the field should be due entirely and solely to the corresponding half object-glass, and the rays forming the other half-field to the other half object-glass. Moreover, it was necessary to utilize circular revolving wedges over one of the half object-glasses for the purpose of producing a deviation of the rays in one half-field as regards the other; and, furthermore, the images were required to be erect. These conditions, though theoretically solvable by introducing a thin diaphragm in whose plane the optical axis of the telescope would lie, are not practicable, as the light impinging on this diaphragm at very long incidence introduces false light into the field and destroys the brilliancy of the images. With this form it is not possible to use circular revolving wedges without a considerable loss of light. By reversing the two half object-glasses and placing them back to back, the introduction of an effective series of diaphragms is rendered possible without cutting off from the cone of rays which form the images, while the positions of the half object-glasses render the application of circular wedges quite possible and convenient. With this arrangement the two semi-circular pencils of light being each reversed in themselves by the erecting prisms, emerge from the eyepiece as on single disk, just fitting the pupil of the eye with the lower powers.

The dust-fiend has now assumed such huge proportions not only on our roads but in our buildings that any practicable means of subjugating its baneful influences should be to the public advantage. Several specifics have been devised to achieve this desideratum, but they have only proved moderately successful; while the primitive methods of watering and distributing damp sawdust have proved not only expensive but practically useless. One medium, however, which experiments have shown to be unusually efficacious has recently been introduced upon the market under the name of "crempoid." By its use wooden floors can be kept as clean as polished linoleum, while the atmosphere is also kept free from dangerous dust particles with comparatively little trouble and expense. The specific is in the form of a liquid, which is sparingly distributed over the floor. Its effect is to weigh all dust particles so that they cannot rise into the air by any means, but roll along the floor when a broom is applied, so that they can be easily collected and removed. As it is not requisite to rub the floor with the medium, application can be effected very quickly, while, when swept, the boards are left perfectly clean and the atmosphere dustless. It is also a powerful germicide. The liquid is mixed with about 80 per cent. of water, and when administered may be left on the floor for four or six weeks, according to the extent of the traffic. Under these circumstances, it is well adapted for use in warehouses, shops, public buildings, theaters, offices and so forth, where the accumulation of dust entails considerable annual expenditure. Crempoid is already being extensively used in schools, libraries, etc., while the executive of the Edinburgh Exhibition employed it for the treatment of the floors in the machinery and industrial buildings, greatly to the satisfaction of the exhibitors. It has the distinct advantage that it has no injurious effects upon the most delicate materials used for ladies' dresses, should they trail upon the floor.

TRADE NOTES AND FORMULÆ.

Cold Water Soap.—35 parts of cocoanut oil, 32 parts of rosin, 33 parts of soda lye, of 36 deg. Bé. Oil and rosin are heated to about 122 deg. F. and the lye quickly stirred in. In making up large quantities, higher temperatures are advantageous. The considerable proportion of free alkali is added purposely to increase the detergent or washing power.

Flexible Insulating Material, for Electric Conductors.—One part each of mineral wax, paraffine, ozokerite; 29 parts of wood tar, 32 parts each of shellac and asbestos, flax or cotton, wood or paper, in a dry, finely pulverized condition, are mixed, at 100 deg. to 212 deg. F. in a kettle and continuously stirred. If a harder mass is required, the proportion of wood tar is reduced. To obtain a particularly hard mass, the wax may be omitted, about 24 parts of crushed slate, infusorial earth, or clay, free from iron, added and the quantity of asbestos, etc., to be added reduced.

Wood Varnish, Preventive of Dry Rot.—The wood surface is painted over two or three times with a fluid consisting of 200 parts of borax, 100 parts boracic acid, 200 parts vinegar spirit, and 2,500 parts of water. This mixture is heated to 167 deg. F. and before application is mixed with 200 parts of alcohol. When this coat, which should be applied in dry weather, is dry, a second coating of the following varnish is given: 200 parts borax, 400 parts shellac, 2,000 parts water, heated until solution is effected and then mixed with 2,000 parts of hot water. If the dry rot has started under the boards, these must of course be taken off, the filling removed, and the entire woodwork coated with the above fluids. In place of the old filling a new under-filling should be used of brown coal or hard coal slack or peat.

Substitute for Indigo.—100 parts of pure logwood extract of 25 deg. Bé, and 25 parts of crude glycerine are well mixed and heated in the water bath to 176 deg. F. Then the following oxidation mixture is added by drops, slowly, the temperature being in the meantime raised, stirring steadily, to 212 deg. F.: 15 parts of chrome-alum and 8 parts bi-chromate of potash are dissolved in 50 parts of hot water and to the cooled solution 12.6 parts of hydrochloric acid of 20 deg. Bé added. Mixing being concluded, the mass is allowed to stand for ¼ to ½ an hour at 212 deg. F. and is then cooled. The fluid is then drawn off clear. (Yield about 160 to 165 parts.) This preparation, dissolved in water at 68 deg. F. in the ratio of 3 to 6 per cent of the weight of the cotton, dyes it simply by raising the temperature of the bath to about 104 deg. F. within half an hour. By diluting this product and adding glucose, possibly saturating with about ½ per cent of carbonate of sodium, we obtain from 100 parts about 1,500 parts of good ink.

Raspberry Syrup.—According to Noerr, the very ripe raspberries, as fresh as possible, are crushed, pressed out and the juice, with an addition of 2 per cent of sugar, allowed to stand 4 to 5 days in the cellar; that is, until a mixture of the filtered juice with spirits of wine or solution of Epsom salts remains clear. It is then strained through a fine tin colander, the juice brought to a boil, removed from the fire and the white of one egg added for each 4½ quarts strained into previously warmed wine bottles and not by any means at once, but after standing for a day in the cellar, filtered, which takes but little time. From the juice syrup can be prepared at once (with sugar free from ultramarine) or it can be racked into quart bottles, sterilized in a steam bath and when sealed air-tight with paraffin may be kept as such for years without losing color or aroma. Filtration of the juice prior to boiling is, according to Noerr, to be strictly avoided, because it does not filter bright, stands for days around in the filter and is very likely to ferment again. The writer disapproves of a temperature of 75 deg. F. because, at a moderate cellar temperature, fermentation proceeds, if somewhat slower, the more uniformly.

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